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SCHOOL NUMBER

BROOKLYN BOTANIC GARDEN
LEAFLETS

THE BROOKLYN INSTITUTE OF ARTS AND SCIENCES

SERIES IV BROOKLYN, N. Y., APRIL 5, 1916. NO. 1

LIST OF TALKS FOR ELEMENTARY SCHOOL CLASSES

The following list of talks is the third one offered at the Brooklyn Botanic Garden. It differs a little from those preceding it in this respect, that certain talks are considered of such importance that these are suggested for all grades. The talks that are recommended for different grades have been carefully selected so that they correlate with the nature study and the geography of those grades.

We feel more than ever that it is important for the boys and girls of Brooklyn to become acquainted with the Garden and know what it has to offer. It is hoped that the children look upon their visits here not only in the light of an outing but as an opportunity for study—the sort of study which cannot be obtained from books, but only from living specimens. It is not an easy thing to conduct classes of children through the city from a school to such an institution as the Botanic Garden, and therefore the work, for which the classes come, should be well worth the teacher's output of energy. These are the things we have to offer: The study from life of plants uncommon to our own locality, read of in books, difficult to see; lessons on plant life not easy to give in class-rooms, but with possibilities of adaptation to school conditions; talks with lantern slides carefully selected to illustrate the subjects; and an acquaintance with trees and wild flowers common to our section, with simple keys for the identification of the same.

Many children visited the Garden last year because of these talks; they came with their teachers, they returned with their fathers and mothers or by themselves. Is not this what the city of Brooklyn desires? One great object in education is to teach children how and where to obtain knowledge.

These talks will be given during school hours from April 10 to May 26, inclusive. It is necessary to give three days' notice upon cards sent to schools on request.

TALKS TO BE GIVEN AT THE BOTANIC GARDEN

For All Grades

I. How to Plant a Garden. (Lantern slides and demonstrations).

II. Our Common Trees. (Lantern slides and outdoor work).

III. Some of our native wild flowers that bloom in April, May and June. (Slides and specimens).

IV. How to make Brooklyn a more beautiful city. (Lantern slides).

For Grades 4a and 4b

V. Cultivation of plants by seeds, slips, runners, etc. (Greenhouse).

VI. What plants need for growth. (Experiments).

VII. Plant variations in the hot, cold and temperate countries. (Lantern slides and specimen plants).

VIII. The cultivation of rice in China and Japan. (Lantern slides).

For Grades 5a and 5b

IX. Plants useful to man. (Lantern slides and living plants).

X. Evergreens and deciduous trees. (Botanic Garden grounds, May-June).

XI. Food plants raised in the United States. (Lantern slides).

XII. Plant industries and products of the United States. (Lantern slides).

XIII. Cotton raising in the South. (Lantern slides).

For Grades 6a and 6b

XIV. Coffee culture in South America. (Lantern slides and living plants).

XV. The rubber industry in South America. (Lantern slides and living plants).

XVI. The class-room window box. (Demonstration).

For Grades 7a and 7b

XVII. Agricultural products of the United States. (Demonstrations).

XVIII. What plants mean to the world's commerce. (Lantern slides).

XIX. The life story of a tree. (Demonstration and slides).

XX. Forestry. (Lantern slides).

NOTE.—The above talks will be given only at the Brooklyn Botanic Garden, where the greenhouses, economic plants and the grounds make it possible to acquaint the children with the living material. Principals and teachers should make appointments for classes at least three days in advance. These talks are listed by grades to correlate with the city syllabus in nature study and geography. Any talk will be given to any class of either public or private schools, regardless of this grading.

TALKS TO BE GIVEN AT SCHOOLS

All Grades.—How to make a garden and prepare for the Annual Children's Garden Exhibit, to be held at the Botanic Garden, September 29 and 30, 1916.

Nature Stories for Children

The following talks, illustrated with lantern slides and plant material, are given on Saturday afternoons at the Brooklyn Botanic Garden and are open to all children on request. Tickets are issued for these talks; only seventy tickets are printed for each. Send for tickets one week in advance; one ticket admits only to the lecture of the date appearing on the face of the ticket.

Schedule of Stories
1916

April 29—How to make a garden	Ellen Eddy Shaw
May 6—How to make Brooklyn more beautiful	Jean Cross
May 13—Rubber, a very useful plant.	Ellen Eddy Shaw
May 20—Sugar, and how it is obtained	Jean Cross
May 27—The wild flowers now in bloom	Dr. Alfred L. Gundersen

There may be other talks on botanical subjects and nature study which teachers desire, and which do not appear on the above list. Such talks, as far as possible, will be given on application by the teacher. All applications should be in writing on cards provided by the Garden for this purpose. These cards read as follows:

School.............................. Grade ....No. of pupils........

Address ....

Date of request...................................

The Assistant Curator of Public Instruction

BROOKLYN BOTANIC GARDEN

I wish to bring my class, as indicated above, to the Botanic

Garden on date.............................at hour.............

for purposes checked below:

1. Talk No.......................for Elementary School Classes
2. A special talk on...
3. Special work in the plant houses.
4. Visit the conservatories under guidance.
5. Visit the out-of-doors collections under guidance.
6. Visit the Japanese Garden.

School telephone ....Teacher

(Additional copies of this card may be had on application)

Ellen Eddy Shaw.

NOTICES

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CHILDREN'S NUMBER

BROOKLYN BOTANIC GARDEN

LEAFLETS

THE BROOKLYN INSTITUTE OF ARTS AND SCIENCES

SERIES IV BROOKLYN, N. Y., APRIL 12, 1916. NO. 2

THE THIRD ANNUAL GARDEN EXHIBIT FOR BROOKLYN BOYS AND GIRLS

The Brooklyn Botanic Garden announces its third annual exhibit for the boys and girls of this city to be held September 29th and 30th. Prizes will be awarded Ootober 14 at three o'clock in the afternoon.

Let us see this year if we can get a clear understanding of the conditions of the contest and so avoid disappointment and mistakes in September. There are ten classes of exhibits, as follows:

Class A.—School Display. The first prize in this class is a bronze statue of Victory; the second a silver cup. Any school may compete for these prizes and the school making the best display receives the first prize, the school making the second best display receives the second prize. The first prize does not become the permanent property of the school winning it until that school wins it three times. Then and only then the school keeps it. Before that it is returned to the Garden each fall to be given to the school winning it that season. Public school 152 has won the trophy twice; should this school win it at the 1916 contest the trophy becomes the property of this school, and the Garden puts up a new trophy at the next contest time. Some people have asked this question: What do you mean by the school display? It is a collection of vegetables, flowers and plants raised by the children of the school in their own home or school gardens. Flowers and vegetables exhibited with the school display do not count toward individual display. But potted plants may be entered both in this class and in Class F.

Class B.—Community Display. This class is intended for those gardens which continue throughout the summer under supervision, as do the Park gardens and certain school gardens. The display in this class may be made up of the products from the individual plots, observation beds and border plantings. Products should not be submitted from plots cared for by gardeners, assistants, or teachers. This is not an exhibit for adults. A first prize will be given in this class.

Class C—Box display. This display will consist of plants and flowers in boxes and of potted plants. There are schools where it is impossible to have a school garden, and where the neighborhood is such that it is impossible to have home gardens; for such cases this class is added. A first prize will be awarded.

Class D—Flowers. This is a class for individual competition and in which first and second prizes are offered. In this and the following classes the first prizes are silver medals and second prizes are bronze medals. Certificates of honorable mention will also be awarded. If a boy or girl enters an individual class he must understand that these same products cannot count toward his school display. Double entries should be made in such cases. Do not forget this. If you enter ten zinnias for an individual prize and wish to add zinnias to the school display, then you must bring two bunches of zinnias, ten in each bunch. The division in class D are as follows:

No. 1. Alyssum
Best plant (potted)
No. 2. Asters, Blue
Best collection of ten
No. 3. Asters, Pink
Best collection of ten
No. 4. Asters, White
Best collection of ten
No. 5. Asters, Mixed
Best collection of ten
No. 6. Calendula
Best collection of eight
No. 7. Cornflower
Best collection of twelve
No. 8. Dianthus
Best collection of ten
No. 9. Marigold
Best collection of twelve
No. 10. Nasturtium
Best collection of twelve
No. 11. Phlox
Best collection of eight
No. 12. Scabiosa
Best collection of six
No. 13. Sunflower
Largest specimen flower
No. 14. Zinnia
Best collection of ten

Class E.—Vegetables. This class is an important one; the products should be those raised by the individual boy or girl. Plan ahead so that you may have fine crops ready for exhibit time.

No. 1. Beans, Bush
Best pint of beans, shelled
No. 2. Beans
Best quart, unshelled
No. 3. Beets
Best bunch of six
No. 4. Carrots
Best bunch of five
No. 5. Corn
Best six ears
No. 6. Egg Plant
Best two
No. 7. Kohlrabi
Best four
No. 8. Lettuce
Best two heads
(roots and all)
No. 9. Onions
Best four
No. 10. Peppers
Best four
No. 11. Radish
Best eight
No. 12. Rhubarb
Best plant
No. 13. Squash
Best one
No. 14. Tomatoes, Green
Best eight
No. 15. Tomatoes, Red
Best six
No. 16. Tomatoes
Dwarf varieties
Best ten

Class F—Best Special Plant. Any plant cared for by the exhibitor may be entered. This plant may be a geranium raised from a cutting, an aster from seed, a fern from a runner, it matters not if the work is yours. The plant stands no chance of prize winning if it is not in good condition, clean, properly potted, and free from insect pests.

Class G—Individual Garden Display. The greatest variety of flowers or vegetables raised by one child, constitutes this display. Here is an opportunity to show some originality and taste in the way you put together and arrange your own exhibit. It is like a miniature flower or vegetable show.

Class H—Weed Display. This weed exhibit may be either one of fresh specimens or of pressed ones. The weeds should be named so we know that you understand what you are exhibiting.

Class I—Wild Flowers. This is an exhibit similar to the one for Class H.

Class J—Back Yard Garden. Any boy or girl may enter his own back yard garden in Class J. Of course it is impossible to bring your yard to the exhibit, but if you wish to compete in this class just drop us a card. Your garden will be visited and judged.

Here is the entire list of classes together. Keep it and refer to it when you need to this summer. Remember: get into this work with the rest: measure up your results with theirs.

Class A—School Display. First prize, a trophy to the school making the best display. Second prize, a silver cup.

Class B—Community Display. First prize, to be awarded.

Class C—Box Display. First prize, to be awarded.

Class D—Flowers. First and second prizes will be awarded.

Class E—Vegetables. First and second prizes will be awarded.

Class F—Best Special Plants. First and second prizes will be awarded. This exhibit may also form a part of that entered in Class A.

Class G—Individual Garden Displays. First and second prizes will be awarded for the greatest variety of flowers or of vegetables raised by any one child.

Class H—Weed Display. First and second prizes will be awarded to the child making the best exhibit of common weeds.

Class I—Wild Flowers. First and second prizes will be awarded for the best collection of wild flowers, either pressed or in natural condition. Exhibit but one specimen of each variety.

Class J—Back Yard Garden. First and second prizes will be offered for the best back yard garden.

If you wish more of these Leaflets for other boys and girls send for them to Brooklyn Botanic Garden, Brooklyn, N. Y.

Prepare now for next September!

Ellen Eddy Shaw.

NOTICES

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BROOKLYN BOTANIC GARDEN

LEAFLETS

THE BROOKLYN INSTITUTE OF ARTS AND SCIENCES

SERIES IV BROOKLYN, N. Y., APRIL 19, 1916. No. 3

TEN COMMON TREES OF BROOKLYN

In a former LEAFLET (Ser. I, No. 7) coniferous trees have been described; ten other genera of trees commonly seen in Brooklyn are here taken up.

Maple.—The maples are readily distinguished as a group by their opposite buds and their usually palmately veined simple leaves. The bark is generally smooth, at least on the branches. The flowers soon develop into a double-winged fruit. The small red flowers of the silver maple and the somewhat more conspicuous ones of the red maple come out before the leaves. In the sugar maple they come out about the same time as the leaves. Two European species often planted here—the Sycamore maple and the Norway maple—have more showy flowers. The Norway maple is very common as a street tree, and is noteworthy in that it has a milky sap. The box-elder, or ash-leaved maple, has bright green twigs and pinnately compound leaves.

Elm.—The elms have simple, pinnately veined leaves, with serrate margins. The bark is rough. The flowers are usually perfect—that is, having both stamens and pistils. They appear before the leaves, and develop into a flat-winged fruit, which falls to the ground early in the season. The American or white elm is one of the tallest of our trees. Its gracefully dividing trunk and branches give it a distinct appearance. The English elm has a form more like an oak. The slippery elm is a smaller tree; it has rather larger leaves with a rough surface.

Plane Tree.—The plane trees, commonly called sycamore or button ball, are very distinct by their peculiar flaky bark and globular, suspended fruit, which remains on the tree through the winter. The leaves resemble maple leaves somewhat, but are alternate; the base of the peticles is hollow and encloses next year's buds. The American plane tree is the largest tree of the Eastern States. The street trees are usually the oriental plane tree, with yellowish under bark, and two or three fruit balls hanging together. The American, or occidental, plane tree has the under bark more nearly white, with the fruits usually suspended singly.

Horse-chestnut.—The horse-chestnut is an Asiatic tree commonly planted in cities because of its regular form and showy flower-clusters. The petals are usually white, spotted with purple and yellow. Only a few of the flowers develop into fruits, which are leathery, prickled burs, enclosing one or two seeds or nuts. The leaves are opposite, palmately compound, with five to seven leaflets. The buckeyes are American trees very similar; some of them have the fruits smooth when mature.

Poplar.—The poplars bear their flowers in two kinds of catkins, staminate and pistillate. These grow on separate trees—that is, they are dioecious. The staminate catkins usually open earlier, being at first brown and later yellow with pollen. The pistillate flowers mature into small bottle-shaped fruits; these open later to let out the downy seeds. Poplars are wind pollinated. The Lombardy poplar is readily known by its tall, cylindrical form. The cottonwood is the largest of the poplars; it is commonly planted where rapid growth is desired. The trembling poplar, or aspen, and the large-toothed poplar are common in the woods.

Willow.—The willows grow mostly in damp places, and have a soft wood. They have usually slender yellow twigs and narrow leaves with stripules. The flowers are very much like those of the poplar, but are fragrant and pollinated by insects. The species are rather difficult to distinguish, since there are many hybrid forms. The weeping willow is an Asiatic species, often planted for its ornamental effect. The weeping effect results from the failure of the branches to develop sufficient mechanical tissue to hold them erect.

Oak.—Oak leaves are simple pinnate, with a more or less wavy or lobed margin. The numerous species of oak fall into two groups that are readily distinguished. The white oak group has round-lobed leaves; the acorns mature in one season; the bark is whitish and flaky. The black oak group has pointed-lobed leaves; the acorns mature in two seasons; the bark is dark. The oaks are monoecious. The staminate flowers form long, drooping catkins. The pistillate flowers grow in clusters and develop into acorns.

Birch.—The papery bark with horizontal "breathing pores" (*lenticels*) and the slender terminal twigs characterize the birches. The leaves are simple pinnate, with serrate margin. The birches are also monoecious; both kinds of flowers are in catkins. They open in early spring, and the pistillate catkins remain on the tree till winter. The fruits are small, one-seeded nuts, usually winged. The white birch is often seen on lawns; the smaller gray birch is common in woods. The leaves of the gray birch are more pointed than those of the white birch; there are dark marks more or less triangular under the branches, and the smaller branches are usually brown (not white, as in the white birch). The sweet black birch is known by its dark bark, and its twigs have a very distinct, pleasant taste.

Linden.—Linden trees are common on the streets. The leaves are alternate and heart-shaped, with serrate margin. The American linden, also called basswood, has a smoother bark and coarser leaves than the European species. The small, cream-colored, fragrant flowers hang from an expanded leafy bract, and develop into woody, globular fruits.

Tulip Tree.—The tulip tree is one of the largest and most useful of American trees. It is a rapidly growing tree. Its smooth three-lobed leaves, with the end apparently cut off (*truncate*) are very distinctive. The stipules, which serve as bud-scales, fall off early in the season, leaving a ridge around the twig. The tulip-shaped, greenish yellow flowers grow mostly on the upper branches. The fruit is cone-like, a part of it often remaining on the tree through the winter.

Some other genera of deciduous trees seen in Brooklyn are walnut, hickory, alder, hornbeam or blue beach, hop-hornbeam or ironwood, beech, hackberry, mulberry, magnolia, sassafras, sweet gum, hawthorn, mountain ash, cherry, locust, honey locust, Judas tree, dogwood, tupelo, ash, and catalpa; these are native of this region. Introduced trees are apple, pear, plum, peach, cherry, ginkgo, cercidiphyllum, Kentucky coffee tree, yellow-wood, ailanthus or tree of heaven, varnish tree, and paulownia.

A. GUNDERSEN.

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LEAFLETS

THE BROOKLYN INSTITUTE OF ARTS AND SCIENCES

SERIES IV BROOKLYN, N. Y., APRIL 26, 1916. NO. 4

THE WILD FLOWER GARDEN IN MAY

The local flora section of the Brooklyn Botanic Garden is near Flatbush Avenue, just south of Mt. Prospect reservoir. In this LEAFLET are mentioned a number of plants which are in flower in this section during the month of May; first, plants of the Buttercup and Lily Families, as each of these is represented by quite a number of early flowers; second, herbaceous plants of other families, and last a few woody plants. The early flowering plants are for the most part found along the shaded path on the border mound.

The hepaticas, with purplish flowers, began blooming in April, and are now sending up three-lobed leaves, which at first are very hairy. There are two species, one (*H. acutiloba*) with the leaf lobes more pointed than the other (*H. triloba*). The little rue-anemone has delicate, white flowers, growing three or four in a cluster. The leaves resemble those of the meadow rue. The wood anemone, coming a little later, has somewhat larger flowers, growing singly, and the leaves have five divisions. The columbine is common on rocky hillsides and the borders of woods. The flowers are magenta-colored with yellow edges, the petals are tube-like, running into spurs with nectar-glands which attract insects for pollination. The golden seal or orange-root has greenish-white flowers. It has a yellow root-stock from which the drug hydrastine is obtained. A little later in May blooms the yellow globeflower, resembling a buttercup, with a solitary terminal flower. The white-flowered baneberries, of which there are two species, have large compound leaves; one species has a red berry, the other a white berry on a thick, red pedicel. The goldthread is a little plant with evergreen, shining leaves, composed of three leaflets, and with a branching underground stem or rootstock, which appears like bright yellow threads, and has an extremely bitter taste. When chewed it is said to afford relief for canker-sore mouth. The bright, yellow-flowered marsh marigold in the bog, is now coming into fruit.

The plants mentioned, though differing widely in appearance, have some resemblance in the structure of the flower; the parts are all separate and attached to an elongated receptacle, and there are numerous stamens and pistils; all are classified in the Buttercup or Crowfoot Family. Other plants of this group may be found in the meadow.

The Lily Family plants have leaves with parallel veining, and the parts of the flowers in threes. Of this group, there will be found along the border mound path, in early May, the bellwort, trillium, and maianthemum. The bellwort has an angled stem, with one or two cream-colored flowers, which develop into a three-cornered capsule. The wake-robin (*Trillium erectum*) and the nodding trillium (*T. cernuum*) have stout stems, three large leaves, three green sepals, and three colored petals. The little white-flowered *Mianthemum canadense*, sometimes called wild lily-of-the-valley, is very common in the woods. Later in the month may be seen the twisted stalk, much like the bellwort, except that the veining of the leaves is more distinct. There is a twist in the flower stem, and the fruit is a berry. The clintonia has large leaves and an inconspicuous straw-colored flower, developing into large blue berries, not edible. Near the lower (southern) part of the wild flower meadow may be seen two species of false Solomon's Seal, with flowers clustered at the top, and two species of the true Solomon's Seal with flowers along the stem. The rootstocks have large round scars from the stalks of the previous year, suggesting the common name.

Other families represented among the native flowers are mustard, poppy, and saxifrage. Along the path is found toothwort, or pepperroot. It has a crisp, edible root. This plant, together with many weeds and vegetables, belongs in the Mustard Family, characterized especially by the four petals and by the four long and two short stamens. The blood-root, of the Poppy Family, growing by the path, has a delicate white flower of brief duration; the fruit is a capsule. The plant has a red sap, especially noticed in the roots. The celandine, which grows commonly about houses, may be seen on the meadow. It has yellow flowers and an orange-colored, poisonous sap.

Three plants of the Saxifrage Family grow along the path. The early saxifrage blooms in rocky places in April and early May; it has a cluster of small white flowers. Later may be seen the foamflower, or false mitrewort, and the mitrewort, or bishop's cap, both with white flowers. The latter has a more slender raceme and blooms a little later.

The plants of the Composite Family for the most part bloom later in the season. The coltsfoot, with yellow flowers followed by large, broad leaves, and the little everlasting, or pussy-toes, flower in April and May in the lower part of the local flora meadow. In the everlasting the stamens and pistils grow on separate plants. The staminate flowers are readily recognized by the brown anthers, while the pistillate ones are white and more silk-like.

The well-known Jack-in-the-pulpit, also called Indian turnip from the shape of the root, comes into flower toward the middle of May. A number of specimens may be found near the bog. As a rule only the stamens or the pistils ripen on one plant. The plants of dark woods are more brightly colored than those growing in the open. The root is extremely bitter, but becomes edible after boiling. The blue-eyed grass is a delicate plant near the bog. Its slender leaves are flat like those of the iris. A few members of the showy orchid family may be seen; the pink and two yellow species of lady's slipper grow along the path, and the purple-fringed orchis in the bog.

The wild ginger has large, heart-shaped leaves, with brownish flowers growing near the ground. The rootstock has a taste somewhat like ginger.

The spring beauty, also along the path, is a delicate pale pink flower, with veins of deeper pink, and grass-like leaves. The mandrake, also called May apple and umbrella leaf, has a large peltate leaf, which opens like an umbrella. The flowering stem bears two other leaves, between which grows the solitary large, white flower of disagreeable scent. The little bluets, or quaker-ladies, will be found in the Madder Family bed, and also in several places among the grass. They are easy to transplant, and may make a continuous bloom in the winter in the house. In the Mint Family bed the creeping Gill-over-the-ground, and the self-heal are among the early flowers. On a grassy bank south of the bog grow the violets. There are more than thirty species in the New York region and they form numerous hybrids.

The wood-sorrels have three leaflets, like the clovers, and a pleasant acid taste. A yellow species is common; the purple wood-sorrel comes from a bulb. The leaflets close if lightly rubbed by the hand, and are very sensitive to changes of light intensity, "going to sleep" each night at dusk.

The tall yellow meadow parsnip continues flowering well into the summer. Of cranesbills or geraniums there are several species on the west side of the path. The small European species, herb Robert, is well established here. The little dwarf dandelion, sometimes called cynthia, has small yellow flowers. It grows in the lower part of the meadow, and is common in sandy soil on Long Island.

Among native woody plants flowering in May in the local flora section may be mentioned the red-bud or Judas-tree, cherries, the shadbush or June berries, hawthorns, ninebark, spiraeas and viburnums. There are also a number of introduced shrubs by the path, such as white kerria, bush honeysuckle, lilac and privet.

A. GUNDERSEN.

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The Director of the Garden will be glad to furnish, on request, full information as to the conditions and privileges of membership.

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BROOKLYN BOTANIC GARDEN

LEAFLETS

THE BROOKLYN INSTITUTE OF ARTS AND SCIENCES

SERIES IV — BROOKLYN, N. Y., MAY 3, 1916. — NO. 5

THE JAPANESE GARDEN

The Japanese Garden, of the Brooklyn Botanic Garden, was first opened to the public on Sunday, June 6, 1915, after a private inspection by members and their friends on the preceding afternoon. This garden is never more attractive than during the first part of May, and will become increasingly beautiful at that season from year to year, as the flowering cherry, plum, and apple trees, and the azalea bushes become larger.

Mr. T. Shiota, the designer of our garden, has tersely defined a Japanese garden as "the natural landscape idealized and pictured forth by real objects on the ground. Just as an artist sketches a scene on canvas," says Mr. Shiota, "so the garden designer represents a beautiful object on the ground by the aid of pick and shovel, using trees, rocks, water, and stones as nature uses them, but employing the principles of three separate arts—painting, sculpture, and architecture—to gain the effects we desire. * * * From the designer's point of view we may describe a Japanese garden as a manifestation of his own ideas of nature, and also as an expression of his admiration for nature."

We go to a Japanese garden, therefore, not to see flowers (as to an American flower garden), but to enjoy the garden itself as an artistic expression of natural scenery.

The site of the Brooklyn Japanese garden is specially favorable, as it includes a portion of the shore of a small lake, and a diversified topography, together with a supply of running water.

On the east shore of the lake is the tea-house and wistaria arbor. The low, broad seats in the tea-house are commonly mistaken for tables. They are, however, intended as seats, and are made broad by the Japanese so as to afford ample room to set one's cup of tea.

From the tea-house a panoramic view of the entire garden may be had across the water. At the right is the moon-view house (*tsuki-tei*), so named because from here, at certain periods, the moon and its reflection in the lake may be seen to advantage, in the late afternoon or early evening.

To the left is a small island with miniature cave, connected with the mainland by a picturesque drum bridge. One may also pass to the mainland by stepping stones artistically placed. South of the island are two bronze storks, imported from Japan, while the most conspicuous object is the stone lantern named *Yuki-mi*, or snow-view, since it is specially admired by the Japanese when covered with snow.

The taller stone lantern, further back on the hill, is called *Okuno-in*, or remote temple. The twelve figures, carved on the six facets of this lantern, represent the Japanese signs of the zodiac. Both lanterns were imported [illegible] and the *Okuno-in* was the gift of the Yama[illegible]

The water is supposed to have worn its way [illegible] ledge over which it falls in picturesque cascades, and [illegible] and color effect, and "mystery" are enhanced by the rese[illegible] caves back of the falls.

Near the top of the hill, at the left, is the Shinto shrine, constructed of California red-wood, and put together without nails, except for the shingles on the roof. In Japan these shrines contain deified figures known as "*Inari Sama*"—hence the special name Inari shrine. The two stone foxes on either side of the entrance gate are the messengers of the gods.

The unusual wooden structure standing in the lake is a *torii* (pronounced "tō-ree"). These structures are always placed before shrines, and indicate the gate to a temple. The name torii is of uncertain derivation, but is generally interpreted to mean "bird-perching gate." The torii in our garden is modelled after the famous one at Miyajima, which stands in the water of the sea, and is the only torii in Japan so placed.

Small wooden piles, like those near the water's edge, are commonly seen along shore lines in Japan, where they have served to hold bamboo supports to prevent the washing away of the land. They are placed in our garden arbitrarily, since they would quite probably be found there were the scene actually in Japan.

The pine trees, trimmed and bent according to Japanese ideals, were, two years ago, growing as upright, symmetrical trees on the eastern side of the lake opposite the tea-house. Our garden is specially fortunate in having such large specimens illustrating the Japanese method of handling trees for scenic effect. It may be noted that these trees are trimmed and bent so that, as viewed from the tea-house, the trunks and branches converge to the "vanishing-point" of the picture, thus accentuating its depth and the apparent distance of the upper falls and hills

In the Japanese mind, the high hill in the background represents heaven, the lower hill at the right centre, man, and the two boulders at the water's edge to the left indicate the region, earth. This motive of heaven, man, and earth runs through all Japanese art from landscape gardens to the arrangement of flowers in a vase; so, in walking through the garden, one will notice rocks, steps, stones, trees, stepping stones, and other objects arranged in threes, in harmony with this same fundamental idea.

C. Stuart Gager.

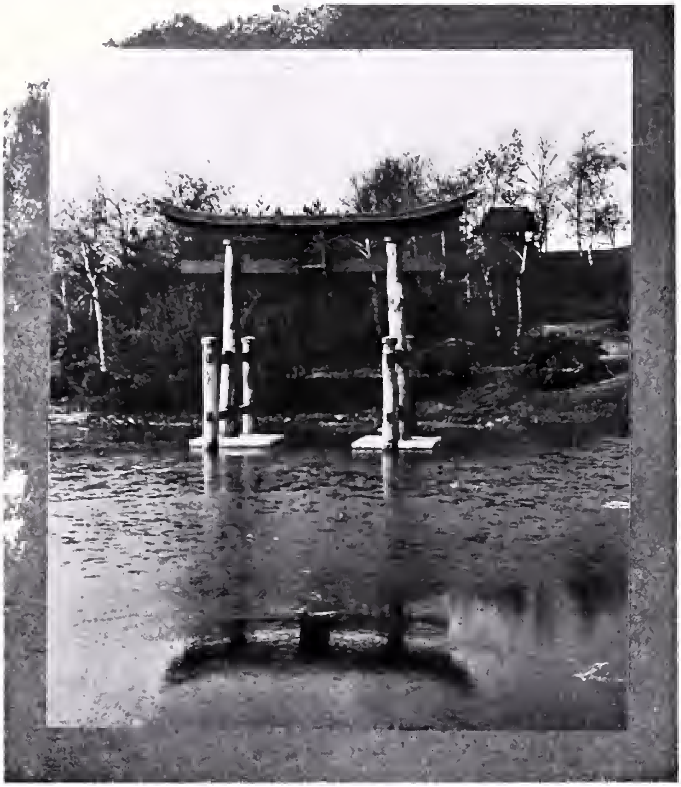

Fig. 1. Japanese Garden: The Torii.

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BROOKLYN BOTANIC GARDEN

LEAFLETS

THE BROOKLYN INSTITUTE OF ARTS AND SCIENCES

SERIES IV BROOKLYN, N. Y., MAY 17, 1916. NO. 6.

POISON IVY

This plant, common in this region, and known scientifically as *Rhus Toxicodendron*, is the bane of a great many people who visit the country or the woods. There are few vacationists who, at one time or another, have not felt the effect of contact with poison ivy. But it is not even necessary to seek the country to find this plant; people in their walks about the city or even in the public parks may meet with poison ivy, for it is not an uncommon sight to find it growing in some waste yard or fence corner right in the heart of Brooklyn. It is truly a "snake in the grass," and anyone passing through an area of natural vegetation is liable, consciously or unconsciously, to touch the poison ivy.

Besides poison ivy, we have another member of the family, common in swamps, the poison sumach or poison dogwood (*Rhus Vernix*), which is even more poisonous to the touch.

Many people, especially Boy Scouts, with whom the knowledge is compulsory, and those who have experienced poisoning from it, have made themselves familiar with the appearance of poison ivy. There are, however, many people who are unfamiliar with this plant; it is not infrequently touched and otherwise handled in summer or autumn, for the plant possesses some beauty, especially when it has assumed autumnal coloration. Needless to say, poisoning usually results from such a procedure. It is not amiss here to describe briefly the appearance of the poison ivy plant.

The leaves are compound, composed of three ovate leaflets, thus being readily distinguished from the Virginia creeper, with five leaflets, with which poison ivy is often confused. Depending somewhat on the conditions, the plant grows as a trailing or climbing vine or else as a more or less erect shrub. The name

"Poison Oak" is often applied when the plant is shrubby. It scrambles over fences and walls; or in thickets and woods it climbs stumps and trees to considerable heights, clinging by means of tiny rootlets.

It is a well-known fact that individuals vary as to susceptibility to poisoning by this plant. There are those who claim immunity and who seem to be able to touch the leaves or stems with impunity. It is doubtful, however, that anyone can hope to allow this plant to touch him indiscriminately and always escape, for even those most "immune" are liable to be affected under certain circumstances; for example, if the plant touches more tender portions of the skin, or places where the skin is scratched or injured, especially if the parts touched are not washed with soap, or otherwise treated, soon after contact with the plant. Most people are especially susceptible when their skin is moist and perspiring. There are, on the other hand, those who suffer greatly from the slightest contact with poison ivy; those who feel its effects not only in a localized irritation and blistering of the skin where the plant touched it, but who suffer irritation or rash over a considerable area, or even, in extreme cases, over the whole body! And there are those who claim that they are affected even by proximity to a plant, or through passing by a fire where it is burning, without even having touched it.

The symptoms of poisoning, as stated above, are irritation and redness, followed by "water blisters." There is a great temptation to scratch the inflamed areas, resulting in breaking the blisters and spreading the poison.

It is an interesting fact that cattle and other herbivorous animals can eat this plant with impunity. Dogs, however, are liable to be poisoned, especially about the mouth, through contact with the poison ivy plant.

For obvious reasons, poison ivy is not a tempting plant with which to experiment. Consequently the poisonous principle is as yet a matter of some discussion. It has been considered by different investigators to be a volatile acid, volatile alkaloid, or volatile oil that caused the disease. The volatile nature of the substance was thought to explain poisoning through merely passing near the plant. However, there is considerable evidence that the poisonous principle is in reality a non-volatile oil. Very minute quantities of this irritating oil may cause the poisoning.

Regarding the length of time it takes for the disease to appear after contact with the plant, it has been found that it may vary from eighteen hours to nine days. Thus it may readily be understood that one may have been in a position to touch a plant, and after a week, when the poisoning finally results, have forgotten the occasion. This may explain many of the cases where poisoning is alleged to have resulted from being only in the vicinity of the plant. But it may also be possible that hairs or pollen grains blown from the plant to susceptible individuals may cause poisoning—truly without any recognizable contact with it.

The most important question is, of course, what should be done to prevent or cure the disease? Answers to this are many in number. Alcohol, solution of permanganate of potassium, saleratus or sodium bicarbonate, alkaline solutions, strong soaps, etc., are found recommended as remedial agents. The justification for the use of alcohol is that it dissolves the oil. There is a great danger in using alcohol, however, namely, that it may, unless large quantities are used to completely wash the poison off, even spread the poison and cause greater penetration!

Alkalies and saleratus are efficacious because they cause a saponification of this poisonous oil, thus rendering it harmless.

Strong soap (yellow laundry soap is best because it contains more free alkali) has been tried and found effective. This is easily obtained, easily carried, and serves a double purpose; i. e., through its deturgent action effects the removal of poisonous particles, and through its alkalinity causes saponification of the poison.

It should be emphasized that after any trip where there is any possibility of poison ivy having been encountered, a thorough wash with strong soap should be resorted to.

If poisoning has occurred, careful washing with strong soap frequently, followed by a drying talcum powder, taking care that the blisters, in breaking, do not spread the poison, should result in no serious results being felt from the disease. If poisoning is severe, a doctor should of course be consulted.

Poison ivy should be exterminated wherever it is known to exist. But much less of the distress due to poisoning would result if people were acquainted with the plant, and kept on the lookout to avoid it; if preventive measures were employed to preclude poisoning (especially soap and water and a scrubbing brush); and if care and intelligence were employed when a local poisoning was found to have occurred.

G. R. Bisby.

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BROOKLYN BOTANIC GARDEN

LEAFLETS

THE BROOKLYN INSTITUTE OF ARTS AND SCIENCES

SERIES IV BROOKLYN, N. Y., JUNE 14, 1916. NO. 7.

THE BROOKLYN BOTANIC GARDEN BOYS' AND GIRLS' CLUBS

The following short articles were written by the boys and girls themselves and explain in their own words how the Boys' and Girls' Clubs of the Brooklyn Botanic Garden happen to be started. We have had a large number of earnest boys and girls working with us, since the laboratory building was opened, in courses extending from periods of six weeks to those of six months or more in length. It seemed wrong not to turn to good use the interest and energy aroused in these boys and girls, and so these clubs, with definite helpful purposes, have been started in order that, as time goes on, the Brooklyn Botanic Garden shall have pledged to its interests a large, intelligent body of up-growing young citizens. It is hoped that once a year one of the LEAFLETS will be devoted to the interests of these clubs.

How the Boys' Club Started

The Boys' Club of the Botanic Garden was formed April 15, 1916. The club consists of about one hundred and thirty boys. From the time the Garden opened there were classes of boys that came to the Garden for instruction. I was in one of the classes of the High School boys, and continued the work until now. I am vice-president of this club. Some say that I was the founder of the club. It was this way: I had been thinking for a long time that the boys ought to band themselves together so we could work better for the Garden. And from this idea of mine the club was started. I expect that this club will have a membership of a thousand within a year or two. This is the only botanical garden that I know of where just such instruction for boys and girls is offered.

NORMAN SCHAEFFER, First Vice-President.

Forming the Club

Norman's idea spread fast. All those that heard it were very enthusiastic about it. Notices went out to the older boys, stating that a meeting would be held in March. Eight High School boys came to draw up the constitution. After four weeks' time the constitution was perfected.

The days passed quickly. On April 15, 1916, a second meeting took place, and over one hundred boys were present to accept the constitution. They voted for a chairman for the next meeting. I was chosen to be this chairman. One hundred boys were present on April 29th to elect their officers for this new organization. The chief officers elected were as follows:

President—CLYDE NELLIS, of Erasmus Hall High School.

First Vice-President—NORMAN W. SCHAEFFER, of Bushwick High School.

Second Vice-President—CHARLES A. SCHMACKE, of P. S. No. 92.

Third Vice-President—HOWARD S. DOELL, of P. S. No. 9.

Corresponding Secretary—MILTON HUDDERS, of Commercial High School.

Recording Secretary—HERMAN HUTCHINS, of Newtown High School.

Chief Treasurer—SAM SIEGELL, of Bushwick High School.

After this, school representatives and sub-treasurers were chosen from each school represented in the club.

At the next meeting, June 3, honorary members were chosen and silver buttons, about which Sam Siegel writes, were presented by Dr. Gager, our Honorary President.

CLYDE NELLIS, President.

Requirements for the Club Pins

Any boy taking any course in the Brooklyn Botanic Garden is entitled to a celluloid button.

Any boy holding three or more certificates obtained from the Brooklyn Botanic Garden or holding two certificates and one medal may receive a bronze pin.

After the boy has received his bronze pin, he is entitled to try for the silver pin. The requirement for this pin is that the boy must experiment along a certain line of botanical work chosen by one of the curators at the Garden for a period of about six months and satisfactory results to be handed in to the curator.

I have been working for mine, and my work has been this: I have collected, mounted and pressed specimens which represent common trees, weeds, flowering and flowerless plants. I am to receive my silver pin June 3.

SAM SIEGELL, Treasurer.

How the Girls' Club Started

The Girls' Club was formed April 22, 1916. The purpose of the organization is to bring the girls who have worked in the gardens, or in the greenhouse, together to work for the Garden itself. We think that we can do better work if we know one another and tell of our experiences.

The club is not one for play, but for work. At our meetings, four times a year, we tell about the work that we have done since the last meeting.

The first meeting was on April 22, 1916. Miss Shaw appointed the officers and the girls voted for the school representatives, and I was appointed president, and so conducted the second meeting, which was held on May 13, 1916. The girls from the different schools told about what they did on Arbor Day, and I told about the laying of the corner-stone of the Garden.

The chief officers of our club are as follows:

President—LILLIAN BAKER, of P. S. No. 9.
First Vice-President—EVELYN SCHELL, of P. S. No. 152.
Second Vice-President—LILLIAN FINEBERG, of P. S. No. 36.
Third Vice-President—BEATRICE MARLENS, of P. S. No. 148.
Chief Treasurer—MILDRED COSTIGAN, of P. S. No. 98.
Corresponding Secretary—HELEN SMITH, of P. S. No. 9.
Recording Secretary—LEOPOLDINE RUPF, of Bushwick High School.

LILLIAN N. BAKER, President.

The Silver Button Work

The work of the "Silver Button Girls" is not very hard, though indeed hard enough. We are now engaged, for one thing, in writing books, of about six chapters each, on seedlings and their growth. The chapters are quite interesting and contain some useful facts and illustrations. The names of the chapters are as follows: "The Bean Seed," "The Needs of a Plant," "The Bean's Growth," "Seed," "Planting a Garden," and last of all, "Friends and Enemies of the Garden". When our books are finished and have been thoroughly examined, a stamp or seal of approval will be pasted in. Neatness and well expressed chapters count a good deal.

For a second thing, we are planting and taking care of large flower and vegetable gardens. The vegetable gardens have already been planted and some of the things have sprouted. When one stands at the head of the Silver Button Gardens, one can see a long, straight, green line of newly sprouted radishes or some other vegetable. Every garden is kept in perfection, not one paper can be seen, not one forgotten hoe, rake or trowel, nothing but lovely, green gardens, filled with good, fresh vegetables.

The flower gardens have been planted a little. Each girl will have quite a space to plant, but the reward is worth having; a garden full of the most beautiful flowers all for ourselves. There will be more work for the girls to do later, but we have no idea of what it will be; but if everything is done satisfactorily, each of the "Silver Button Girls" girls will be given a fine silver button as a reward for her good attendance, behavior, and care of her garden.

RUTH SCHULMAN, P. S. No. 9.

The Work for Bronze and Silver Buttons

This year the work of the Brooklyn Botanic Garden was arranged a little differently. The children having received three certificates are entitled to wear a bronze pin. To obtain a certificate a girl must take one course of study in the Brooklyn Botanic Garden. This may be outdoor work in the summer, or greenhouse work in the fall, winter, or spring. At the end of one course she receives a certificate stating the completion of it.

After she has received a bronze pin she is put at special work to obtain a silver one. After six months of satisfactory work she receives this.

Some of the special work is done in classes of ten or twelve in each. One of these classes, which I am in, has had the pleasant study of seedlings. We are now at special outdoor garden work. Our gardens are arranged in one long strip of land. Each girl has a section of this, eight by ten feet, to plant and take care of. One foot from the center of one garden on either side are planted string beans. One foot from these is planted kohlrabi; white on one side and purple Vienna on the other. Six inches from the white kohlrabi are planted beets, and six inches from that onion sets, then radishes. On the other side, also six inches apart from each other, are planted carrots, lettuce, and radishes. For a border to the Children's Gardens the Silver Button Workers are going to plant a large bed of flowers.

After the children have received their silver buttons they may become honorary members of the Brooklyn Botanic Garden Clubs for Girls and Boys of which they have been active members. If an honorary member wants to pay dues and attend the meetings, he or she may still be an active member, eligible for office.

M. Elinore Hartman, P. S. No. 9.

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LEAFLETS

THE BROOKLYN INSTITUTE OF ARTS AND SCIENCES

SERIES IV BROOKLYN, N. Y., JUNE 21, 1916. NO. 8.

FIELD TRIPS FOR THE STUDY OF VARIATION AND EVOLUTION

The other day I saw a stretch of New England hillside three blocks long covered with a wild double-flowered form of the common Celandine (*Chelidonium majus*). The adjacent hillsides for miles were scoured for other patches, but none but single-flowered plants were to be found. So I concluded this patch was the result of an isolated variation in form of a single plant which had chanced to occur in a favorable situation and spread till it numbered its peculiar kind by the thousands.

Thus it is that many of our most striking forms of cultivated flowers, fruits and vegetables have arisen—simply chance variations which fortunately have occurred in cultivated grounds and caught the eye of the men who tended them. For though these variations are found among wild as well as among cultivated plants, the wild variants seldom are fortunate enough to persist and spread, partly because many of these new forms differ from their immediate relatives by characters which are handicaps in their own unaided struggle for existence, though these handicaps are often what make them most prized by man.

To mention a few cases with such handicaps, take the California navel orange, most double-flowering plants, and the yellow carnation. The navel orange originated about 1822 in Bahia, Brazil, as a branch bearing seedless oranges, on a tree, the other branches of which bore only oranges having seeds. The branch was discovered, and trees entirely navel orange bearing propagated from it by a Portuguese gardener. In 1870 it was introduced into the United States and a few years later into California, first at Riverside, where two of the original trees may still be seen. Left to itself, the navel orange variation would probably have disappeared in a few years by being overgrown by younger branches, or have been pruned out. As it was handicapped by having only seedless fruits, it would have been lost to the world forever, though this handicap is one of the chief characters that make it prized.

Double-flowered variations of most single-flowered plants are generally either wholly seedless or capable of producing only a few seeds as compared to the single-flowering parent varieties, and usually there is nothing else about a double-flowering variety that makes up for this handicap in its struggle to increase its kind—no greater ability to reproduce itself by suckers, or by bulblets, etc.—and so, unless discovered in time by man, it perishes. In botanical excursions, quite a number of times I have found these double or semi-double flowered forms, but only as single plants generally.

In the yellow carnation, a handicap of another type is found—the varieties for some unknown reason seem to be more prone to disease than varieties with flowers of other colors.

Still another common variation in plants which handicaps its possessors is albinism, especially when it occurs in leaves and stems. The chlorophyll, which gives the green color to plants, is the plant's food manufactory, and if even part of the foliage lacks this green chlorophyll, the plant is in the same fix in the struggle for existence as a battleship in battle with only one side equipped with guns and armor. When the green is wholly lacking, as quite often happens in corn (*Zea mays*), the plants die when a few inches high, after the reserve food in the seed has been used up.

In the great majority of cases a multitude of conditions rather than any one condition governs the ability of a new variation to reproduce itself and compete with other members of its community, and the nature of these conditions is but little known as far as specific cases are concerned.

When variations are not handicaps, and particularly if they give their possessor an advantage over the other plants of their kind or of their community, new wild varieties, sub-species, and eventually new species themselves are formed; but variations are probably more often handicaps than advantageous, and thus, unless the hand of man intervenes, more new forms perish unknown than succeed in maintaining themselves until they become numerous enough to be called a new species.

In watching out for variations among wild plants and recording and preserving them, together with date as to place, time of year, character of soil, evidence if any of disease, etc., much pleasure and some profit is to be attained. If the variations are preserved and seed can be obtained and planted, more light on the nature of variation in wild plants can be secured. In some cases, the discovery of and preservation of these variations in wild plants has resulted in worthy additions to our cultivated plants. For example, the red sunflower sold by Peter Henderson & Co. and by other seedsmen is the result of finding a red-flowered variation of the ordinary yellow sunflower by a roadside in Colorado. The wife of Professor Cockerell, of the University of Colorado, found the original plant and saved seed from it, which in a few years, through selection and crossing, gave a strain breeding comparatively true to red flowers. In somewhat the same way the red-flowered form of the California poppy and the Shirley type of poppy were found and introduced into cultivation.

Now many of our wild plants are extremely variable, and those interested in collecting plants and making herbariums would, I am sure, find it extremely interesting to collect all the wild forms of a small group of plants, disregarding whether or not such forms are recognized in the manuals. Such a collection of dried specimens of the genus *Viola*, *Kalmia*, *Phlox* or any other group would be of much assistance in studying variation and evolution in the plant world. Such studies and collections have been made in a few cases, and the light they have thrown on the nature and instability of species is marvellous.

So when we take our collecting can and go on botanical excursions, let us keep on the lookout for all sorts of variations.

ORLAND E. WHITE.

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Telephone: 6173 Prospect.

Mail address: Brooklyn Botanic Garden, Brooklyn, N. Y.

BROOKLYN BOTANIC GARDEN

LEAFLETS

THE BROOKLYN INSTITUTE OF ARTS AND SCIENCES

SERIES IV BROOKLYN, N. Y., JUNE 28, 1916. NO. 9.

VARIATION, ENVIRONMENT AND THE LAWS OF HEREDITY

Endless variety is the most striking fact about the planet on which we live. Even the great expanses of desert only appear monotonous and so undiversified as regards the plant and animal life which they support because we unconsciously compare such regions with those more richly endowed. So seldom are two living things produced exactly alike that their discovery, especially among human beings, causes the greatest wonderment. Our neighbors and acquaintances are short or tall, with all degrees of intermediates between. Their eyes are brown, gray, hazel, blue, pink, and a score of undifferentiated intermediate shades. Their hair comprises all degrees of diversity in form and color from that which hangs in long golden ringlets to that of the deepest, straightest black. Their temperaments, as well as almost every other character they possess, represent an enormous amount of diversity. Even those characters which we commonly are prone to think are absolutely unvariable, such as the number of fingers and toes, occasionally exhibit variation. In fact there are said to be whole families, and in one case a tribe, with more than the normal number of fingers and toes. Close relationship, as among the members of the same family, does not eliminate this diversity of character. How many times are we driven to the most wild speculations to account for differences between brothers, between sisters, or between children and parents. Some characteristics we ascribe to heredity, others we lay to environment, but in many cases neither heredity nor environment seem to account for the appearance of strange characters.

In the plant world, as in human beings, exact likenesses are rare. And this is true, even when plants are of the same variety, coming from seed produced by many generations of inbreeding. But what is still more striking is the diversity among plants propagated by cuttings, budding, grafting, or by offshoots—plants that are only isolated parts of the same plant—as, for example, the Boston fern and its varieties, our fruit trees and berry bushes, and most of our house and bedding plants. You have no trouble in distinguishing your own house plants—your own pots of geraniums, aspidistras, crotons, and ferns from those of your neighbor. Detailed observations have taught us that even the leaves, flowers, and branches of the same plant, as well as the plant individuals themselves, are as unlike each other in many cases as are our friends. Examine the leaves of a mulberry tree, or those of a fern-leaved beech, and see for yourself the numerous forms they take on even the same branch. Compare a dozen radishes of the same variety pulled at random from your own garden, note their differences, and be convinced of the commonness of intra-varietal variation.

The navel oranges of the west all come from parts of the same tree, a tree discovered near Bahia, Brazil, the fore part of the last century. Yet every one knows that navel oranges are of numerous grades and kinds—as to form and coloring, sweetness and sourness, thickness of the rind, size, etc. Those grown in Florida (for they were once tried out there) were sweeter than the California product. In those from Arizona, the rind has at least doubled in thickness. What is true of the orange is true of the apple varieties. The Albemarle pippin from Virginia is a different apple in taste and flavor from those of the same variety grown in California. Western apples of almost any variety are deeper and more highly colored than those of the same variety from the eastern states, while the apples of this latter region are on the whole better flavored. In cool elevated regions, the shape of the fruit of most varieties changes to a flatter form than those of the same variety grown in plains regions. Even the much despised Ben Davis loses some of its pumpkin-like texture and potato-like taste when grown in the region where it originated.

Cabbage grown in the tropics never heads. Varieties of watermelon resistant to certain diseases in Georgia appear to lose this characteristic when subjected to the same disease on the Pacific coast. The same thing is true of disease-resistant varieties of grain—the rust resistant wheats of Australia lost their immunity when grown in North Dakota. The flax growers of the northwestern states were threatened with the destruction of their crops by a disease called flax wilt, but fortunately some of the flax plants were immune to the disease and these were isolated and resistant varieties produced. Perhaps the most striking variations are those commonly styled "freaks"—such as pineapples with thirty crowns, two-headed turtles, five-legged lambs, apple trees naturally producing both red and yellow apples, fasciated plants from normal ancestors,—the common example of which is the garden cockscomb. In a park in Beecroft, Australia, there is an especially striking example of fasciation in the Norfork Island Pine—the specimen resembling a giant cockscomb (Celosia) over twenty six feet high.

Fasciation (flattened stem) is probably found in all species of plants and another striking example is that of a single plant discovered near Alquiza, Cuba, in a field of Havana or Cuban tobacco, a variety normally possessing only 18 to 24 commercial leaves, but the fasciated specimen had over one hundred and fifty. On the Pacific coast, spraying orchards with insect poisons is a general and efficient practice, but recently, a scientist has made certain observations which seem to show that the present kinds of spray remedies may not always prove efficient, as constant spraying has served as a selective agent whereby certain insect individuals naturally immune to the spray, have been isolated and enabled to increase more rapidly because of the destruction of their non-immune brethren, just as contagious diseases among the Chinese from time to time have killed off those which lack natural immunity until now, as a race, they are practically immune to a large number of the diseases which are fatal to Europeans.

So great a place in the living world has this thing called variability that, with all their very best efforts put forward, our breeders, agriculturists and seedsmen have hard work to keep it within legitimate bounds. Vegetables and flowering plants must be carefully watched on the big seed farms to keep down the rogues or worthless variations. Stock breeders must be ever on the alert to keep their breeding animals up to the standard breed type. Grain growers, potato farmers and florists suffer from the so-called "running out" of once valuable varieties. Varieties of fruit and vegetables valuable in one locality prove worthless in another, and *vice versa*. That is why our forefathers here in America had to start all over again instead of using the varieties they brought from their old home. That also is the reason why the national Department of Agriculture has explorers and correspondents in all parts of the world on the lookout for new varieties of vegetables, flowers, and fruits which it tests in this country, though the majority of them prove worthless. Varieties of plants and animals are very likely to develop new traits and new characters when exposed to new sets of conditions. The tall trees of one climate may be the dwarfs of another. The obscure and little known insects and wild plants of one country may be the scourges of another, as for example the Chinese San Jose scale in America, the American cactus in Australia, the Russian thistle in western America. Cultivated forms of the weeds of the tropics often become the garden and hothouse plants of the temperate zones.

But on the other hand, after all has been said concerning variability, it is still a fact that certain living organisms are so strikingly similar as regards certain characters, that we are able to classify them roughly into varieties, species, genera and families. At the same time this grouping is in many respects artificial and must always remain more or less so—serving largely as a convenient method of keeping track of them—of pigeon-holing them, so to speak, so that we may talk about them. A striking illustration of the stability of certain characters is that exhibited by plants propagated by bulbs such as tulips and hyacinths. We are told on the authority of Darwin that a certain Dutch bulb-grower was repeatedly able to indentify 1200 varieties of hyacinths by observations on the bulbs alone. There are said to be over 200,000 reliable species of plants and for the most part there is very little difficulty in identifying them by certain character descriptions. But often these species are not so sharply differentiated as the descriptions in the manuals would lead one to infer, and individuals which one specialist might consider as species *A* would be classified by an equally eminent authority as species *B*. The story is told of a certain eminent botanist to whom was sent a plant for identification, that he identified it as species *A* the first year and on receiving specimens of the same plant the second year, he classified it as species *B*, remarking in self-defense when the mistake was explained to him, that his conception of species *A* had changed in the *interim*. Such plants as the little shepherd's purse and the brake-fern occur in the temperate zones of both hemispheres, and are easily identified. But some species are radically different in appearance under different conditions just as certain varieties of blue-flowered hydrangea become pink-flowered when grown in soil containing alum, and a certain variety of primrose with red flowers has only white flowers when the temperature in which it generally grows is lowered ten degrees.

Variation is so much the rule among the characters of some plants that even the greatest specialists on classification find it practically impossible to classify them so that one of them will understand what the other is talking about. For example, the genus *Rubus*, to which our blackberries and raspberries belong, contains, so some authorities say, 1,500 species, while to others there are only about 200 groups. When the attempt is made to to call all the individuals springing from the seed of the same plant a species, variation steps in and causes trouble, because like does not produce like in the natural world in any but the most superficial sense. Hybridization is extremely common among all crossed-fertilized plants, and the characters of one species are shuffled and combined with those of another in the offspring, so that often a motley array of progeny is produced when seed is sown. Variation also arises through other agencies. But in nature, unless such new types are especially fortunate in their surroundings, they perish. The same species of wild plants that apparently breed so true in nature, when brought into cultivation under the watchful eye of the gardener in most cases become extremely variable—perhaps because the gardener is on the watch and gives the new variation a chance. At any rate, wild species under cultivation generally break up into a large number of forms so strikingly different from each other as would merit specific rank had they been found wild. Take the sweet pea—the purplish-red flowered wild ancestral species is native to Sicily, and occasionally white-flowered sports are found wild. The varieties of sweet peas are legion now, and many would be accorded specific rank unhesitatingly were they found wild. The same is true of the petunia—which ancestrally traces its origin back to

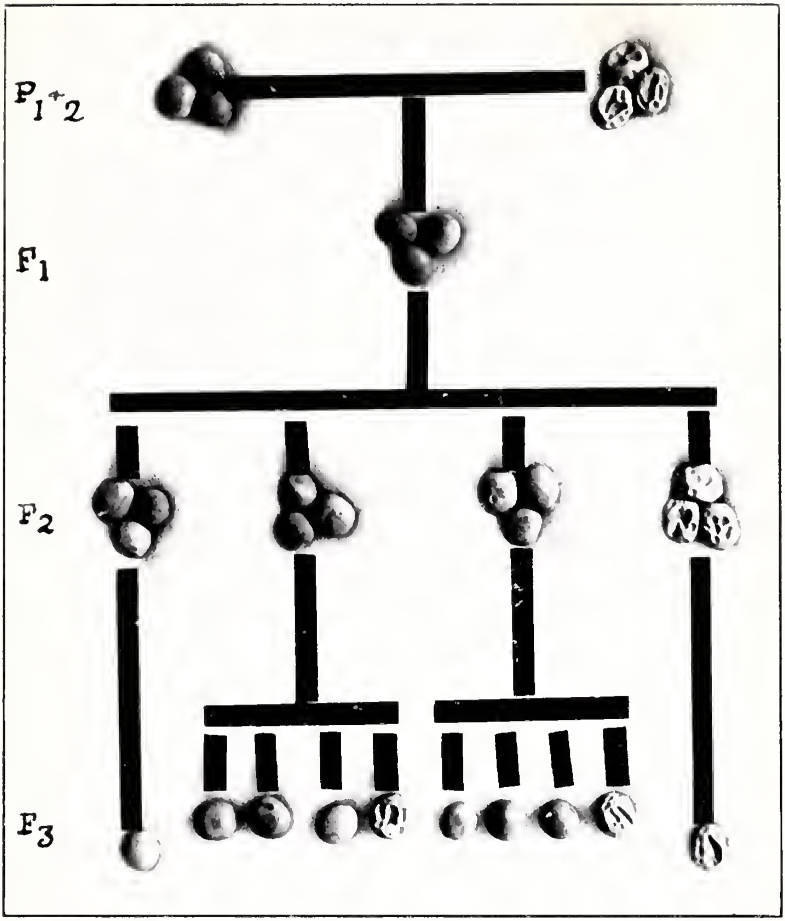


Fig. 1. Diagram showing results of crossing a variety of pea with smooth, round seeds with one breeding true to wrinkled seeds. P designates the two parent types; F_1, F_2 and F_3, the character of the successive hybrid generations.

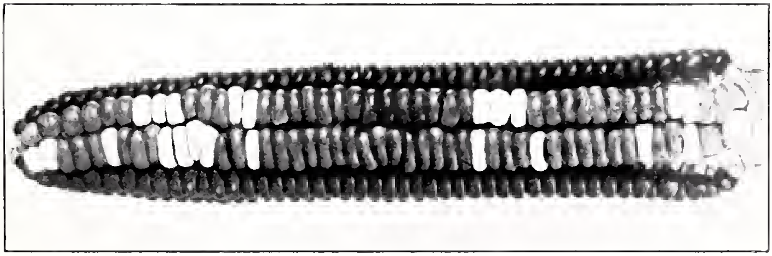


Fig. 2. An ear of corn resulting from crossing a variety having white grains with one having yellow grains, showing the F_2 ratio of three yellow to one white grain (after East and Hayes).

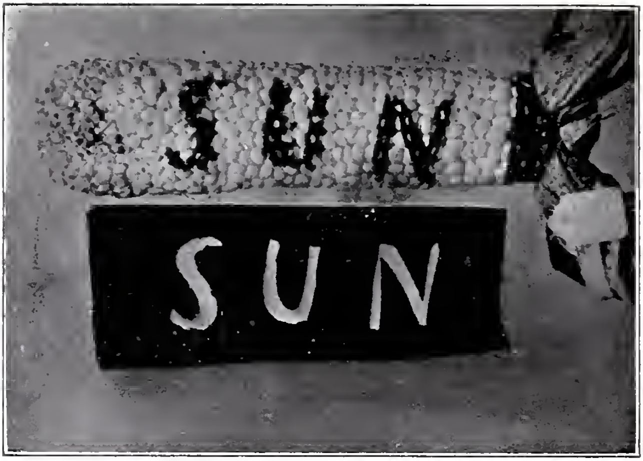


Fig. 3. An illustration of how environment may alter a character. This variety of corn has ears which remain white under normal conditions, but when allowed to mature in the sunlight by removing the husk it colors red. Enclosing it in black paper, with the word "sun" cut out, gave the above result, the exposed portions being red, the unexposed grains remaining white (after Emerson).

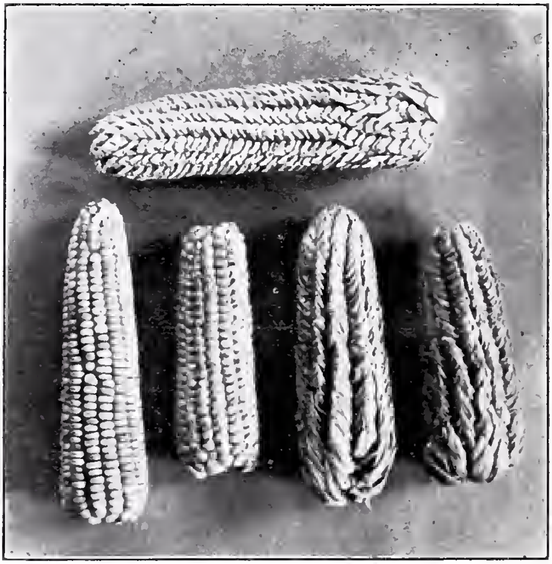
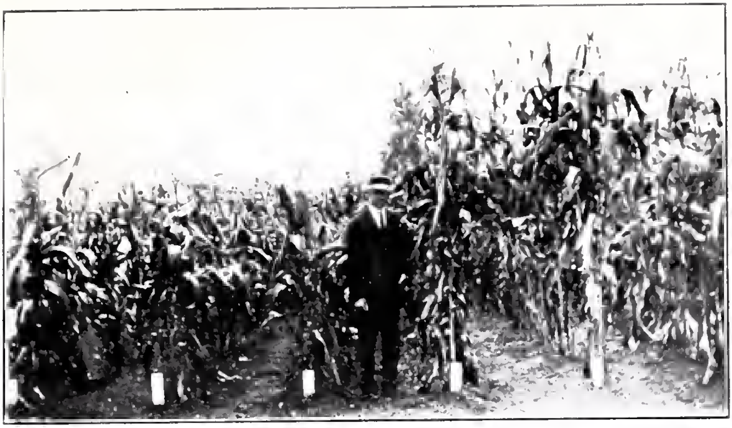
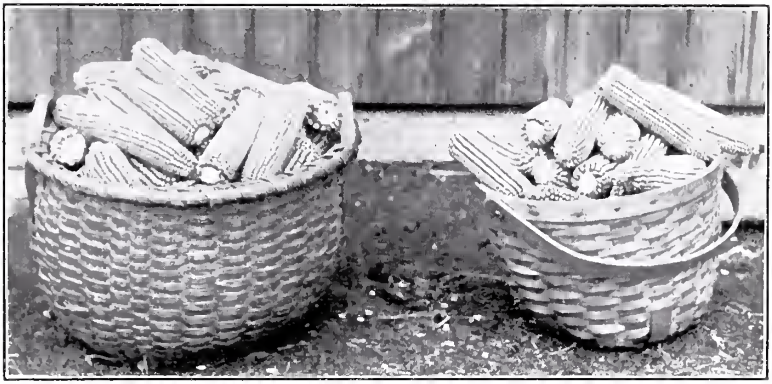


Fig. 4. Mendelian inheritance of "podded" character in corn. The first hybrid generation above, from a cross of pod and ordinary corn; the four ears beneath representing the character of the F_2 or second hybrid generation. In pod corn, each grain is enclosed by a husk (after East and Hayes).





Figs. 5 and 6. Results of crossing two inbred strains of corn. At the left in Fig. 5 are two inbred varieties. The tall corn at the right is the result of crossing them. In Fig. 6, the basket at the right represents the average production of two inbred strains after three generations of inbreeding—61 bushels per acre. The basket at the left shows the first generation results from crossing them—101 bushels per acre (after East and Hayes).

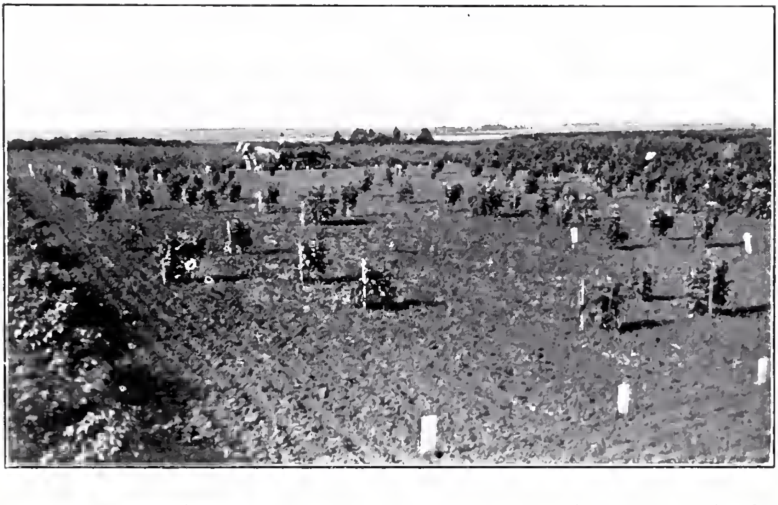


Fig. 7. The "survival of the fittest." Breeding red raspberries to secure a hardy, non-winter-killing type for the northern plains region. The staked plants represent the best selections from a large field of crosses and seedlings (after Hansen).

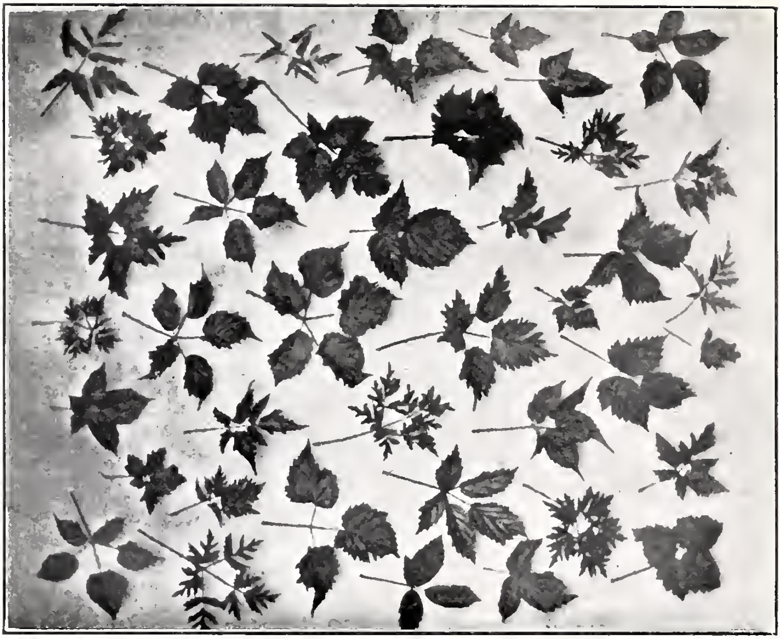


Fig. 8. The various types of leaves from progeny of a single hybrid blackberry plant (after de Vries).

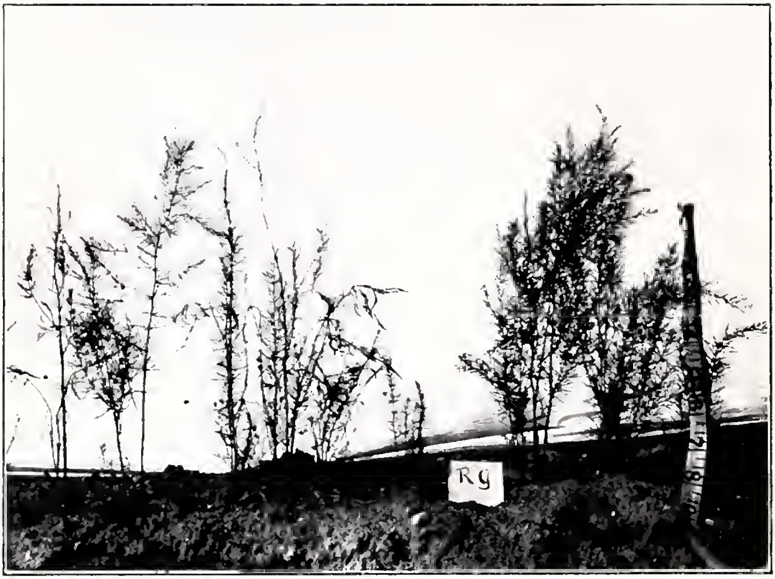


Fig. 9. Breeding disease-resistance asparagus at the U. S. asparagus experiment station at Concord, Mass. On the right are disease-resistant plants, while those on the left are about half destroyed by disease (after Norton).

two wild South American species. Only after careful isolation of single plants and several generations of purification by inbreeding does like begin to produce like. By such methods variability is reduced to a minimum, and a comparatively pure breeding strain or variety created.

For centuries scientific men have grappled with this problem of variation, attempting to discover some law or order in all the seeming chaos that it produces. When certain characters were common to both parent and offspring they called it heredity, but often other characters appeared—characters that had been ununknown to the ancestral line for generations. The breed of chickens called Blue Andalusian presented an extremely perplexing problem, as about one-fourth of the eggs always produced sooty whites, and another fourth black chickens, only one-half being typical Andalusian. No amount of selection and inbreeding reduced the number of these off-types. Such cases made men despair of finding any laws of heredity or variation. As soon as one was formulated, innumerable exceptions arose which shortly proved the law a fallacy. Superstition was common. Strawberry-like birth marks appeared on children because the mother had seen or dreamed of strawberries preceding its birth. Hours were spent before beautiful statues and paintings, that the unborn child might be beautiful. The breeding of fine mares to scrub or undesirable stallions for a single time was supposed later to mar the offspring of these same mares by fine stallions. Experiments by scientific men were few and far between and largely resulted in collections of interesting but isolated facts. What was specially needed was some one who could arrange and correlate these facts into a general law. "Heredity," wrote Balzac, "is a maze in which science loses itself."

Then came the Austrian monk, Gregor Mendel, a man with a mathematical, analytical mind. With the insight and perseverance characteristic of genius, he outlined some experiments which he believed would throw light on the inheritance of characters and bring order out of chaos. After much experimenting, he selected peas as the material most favorable for his purpose, made certain that the varieties bred true in certain well-defined characters, and proceeded with some crossing experiments between varieties differing from each other in one or more of these tested, true-breeding characters. When a plant with reddish-purple flowers was crossed with one having white flowers, the offspring were not pink, as one might naturally expect, but all were reddish-purple flowered. When the seed of any one of these reddish-purple flowered plants was planted, both white and colored-flowered plants were produced in the ratio of one with white flowers to three with colored flowers. All the whites and approximately one-third of those having colored flowers bred true to their respective colors in the next or third hybrid generation (F_3). The other colored-flowered plants (approximately two-thirds of all those with colored flowers) produced seed which again gave the ratio of three with colored flowers to one with white flowers. From extensive experiments tried since, involving large numbers, we have every reason to believe that two-thirds of those with colored flowers from such a cross after the first generation would always produce plants with colored flowers and plants with white flowers in approximately the three to one ratio. Other pea characters, amounting to twelve in all (six pairs), were tested by Mendel in this manner, and the results they gave agreed with those of the experiment just cited. These included such characters as the color of the seedcoat, the color and shape of the cotyledons, the height of the plants, the color of the pods, and the nature of the stem (fasciated or normal). After satisfying himself as to the manner in which a single pair of characters is inherited, he crossed varieties which bred true to two of these differentiating characters. When tall, yellow-seeded peas were crossed with dwarf green-seeded peas, the offspring were all uniformly tall and yellow-seeded. When seed of these were sown, four kinds of progeny were produced in approximately the following ratio: nine tall yellow-seeded, three tall green-seeded, three dwarf yellow-seeded, and one dwarf green-seeded. Out of each group a definite proportion bred true to both characters,—in the first, approximately one in every nine; in each of the next two groups, one in every three, and in the last group, the dwarf green-seeded plants all bred true.

Space is too short to deal with the character of the remaining offspring in the other three groups except to say that a general law was followed. Although still more elaborate experiments were made, extending over a period of eight years in which varieties differing in three sets of characters were crossed, nothing of an exceptional nature was discovered. So from these and other results, Mendel formulated the first clear law of heredity extant—the so-called *law of segregation*. He found that the different characters in his peas appeared to be inherited as units, and that such a character as tallness could be transferred from a green-seeded variety to one with yellow seeds independently of the other characters such as green seeds, with which it had hitherto been associated. The next step naturally then was to make a general application of the law —in other words— to consider all animals and plants as being made up of many independent character materials, each of which could be separately inherited. But, as with most pioneers, scant attention was given to the laws and discoveries which he published in 1865 in the transactions of the local scientific society of Brünn, and after the thirty-five years that his work remained unnoticed, Mendel died, a disappointed and discouraged old man.

In 1900, three Europeon botanists—Correns, deVries and von Tschermak—experimenting along similar lines, each independently rediscovered the law, and Mendel's long forgotten and neglected account was resurrected and once more brought to public notice. This time a hearing was gladly granted, a new science grew up, and general interest in plant and animal breeding spread with cyclone rapidity. The study of heredity became a fad which reached its height in the so-called science of eugenics. Through Mendel's work, and the encouragement derived from his discoveries, the nature of variation and heredity and their relation to environment is beginning to be understood. Variation can now be classified from the standpoint of cause, instead of only by form or by appearance. When three varieties of beans, each breeding true to white seed, are crossed with a single variety of bean breeding true to red coats and in each cross, a different colored progeny is obtained (black, dark blue with white specks, brown gray), we are not forced back to the old time chaos. Thanks to Mendel's methods and conception, we have a key by which we are able to see law and order in this seemingly contradictory result. And what is far more important, we are able to repeat this performance again and again with the same results.

Since 1900 many important modifications of Mendel's original conception have come about, as might be expected when scores of experimenters are engrossed in the experimental study of hundreds of different plant and animal forms. Important among these modifications is our conception of what constitutes a character. We have been forced to drop the vague meaning attached to this term by the older biologists and adopt the usage of the chemists and physicists. In this sense, a character must always be looked upon as the combined result of heredity and environment. The heredity units themselves are not characters in any sense, but, in conjunction with environment, express themselves as characters. The units themselves are to be regarded as the primary elements of the "living" world, just as oxygen and sulphur represent elements of the so-called inorganic world. Another modification of Mendel's conception is that of linkage. For we find that certain characters are either partially or always inherited along with other characters, not always separately as Mendel supposed. Many of these characters in certain animals are sex-linked. In the little banana fly, over one hundred of these differential heredity units have been studied and instead of finding that each is inherited independently of all the others, the discovery has been made that they are inherited as though more or less loosely linked together in four groups. In plants similar discoveries have been made though not on as large a scale. In peas themselves, colored flowers are found to be partially linked or coupled with the materials responsible for late flowering, while the white flowers are partially associated with the materials responsible for early flowering time. One pea variety with no tendrils and having wrinkled seed, crossed with a smooth seeded, tendrilled variety gives only smooth seeded, tendrilled offspring in the first generation, while in the second, where four types of plants are expected in the proportion of 9ST: 3WT: 3SN—T: 1WN—T, approximately only two appear, the two central groups being represented by very few individuals. The two outside groups of course are the same combinations as found in the original parents of the cross, and though the two characters naturally would not be expected to be associated in any way, experimental work has shown us that they are almost completely coupled. There are numerous other modifications of Mendel's ideas, but all of these, though important, are to be regarded as superstructures built by the methods and on the foundation stones laid down by Mendel.

Through the light thrown upon the nature and inheritance of characters by Mendelism, experimenters soon came to a radically different conception regarding the rôle selection played in the creation of new varieties. They found that certain varieties of wheat, beans, and other plants, once freed from impurities by constant inbreeding, practically bred true, provided they were always subjected to the same environmental conditions. Certain varieties of wheat thus treated by the Vilmorin family of France have remained stable for forty years. Some varieties of peas are said to have bred true for a still longer period. Sugar per cent in sugar beets has not been appreciably increased over that obtained during the first few years when the selection for a high percentage of sugar began, although more stable varieties have been obtained. On the basis of this kind of evidence, together with that obtained from more recent experimental studies, selection is found not to be the creative agent Darwin and most of the eighteenth century breeders and scientists supposed. Selection, so many experimenters believe, cannot alter the nature of the hereditary units, nor can it cause them to come into existence. Chance, or fortuitous variation, brought about no one knows how, seems to be the only method by which new units arise. To obtain a blue rose from a red-flowered variety, one must wait, so most scientific breeders believe, until a blue-flowered variation occurs—for selection is of no avail except as a method of isolating desired variations that are already in existence. When such variations arise in naturally inbred plants, such as peas, they generally breed true at once; but in cross-fertilized species, such as corn, purification by selection must be practiced to secure a true breeding strain.

Inasmuch as most of the higher plants and animals result from a union of two microscopic cells, and as each of these cells may carry the hereditary units which together with environment are responsible for the characters of these organisms, it follows that every sexually produced animal or plant that breeds true for several successive generations must have at least two of these units, identical in every respect, for *each of the characters* in which it breeds true. The only exceptions are those cases where a number of characters result from one kind of unit, in which case two of these units, exactly alike, may be responsible for several characters, as, for example, in the characters pink flower color, red leaf axil color, and gray seed coat color, in peas.

Granting for the time being that the Mendelian method of analysis is applicable to practically all the characters of the world of living organisms,—that plants and animals are made up of independently inherited units, which, in combination with environment and with each other, express themselves as characters; and granting further that these units are unvariable and not modifiable by selections, how can we arrange and account for all the variation we see about us?

If the conceptions of Mendel and his followers hold as regards the composition of organisms, variations may only occur:—

1. When the complex of heredity units constituting the organism remains the same, and the external environment (e. g., soil, climate, food) is changed.
2. When one or more of these units is added to or subtracted from the organism (through crossing), the external environment remaining unchanged.
3. When both the complex of hereditary units and the environment are altered.
4. When the environment remains the same, but the complex of hereditary units (the organism) is altered by the "addition" of a new hereditary unit, or the "subtraction" of an old one (mutation).

All four of these statements find illustration in almost every plant breeder's experimental garden. In the Brooklyn Botanic Garden, the plant material for the study of heredity is largely made up of peas and castor beans, in which many units have been isolated. In Boston, at the Bussey Institution of Harvard University, the material is tobacco and corn; and among animals, mice, guinea pigs, rats, and rabbits are undergoing investigation. At Cornell University, beans and garden phlox are being studied; while at Columbia University students are working on thousands of the little banana fly, in over one hundred and fifty varieties. In peas, about thirty of these units have been isolated, so that some varieties of peas written in Mendelian formula would appear as AABBCCDDEEFFGG, etc., each letter standing for a particular type of unit. In corn, as many as thirty are known, while in the banana fly about a hundred have been isolated.

In a former LEAFLET (Ser. III, No. 10 & 11), directions are given for carrying out plant-breeding experiments in one's own garden—a field capable of affording much pleasure and some profit.

ORLAND E. WHITE.

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BROOKLYN BOTANIC GARDEN

LEAFLETS

THE BROOKLYN INSTITUTE OF ARTS AND SCIENCES

SERIES IV BROOKLYN, N. Y., SEPTEMBER 13, 1916. NO. 10

BULB CULTURE*

Bulbs are easier to raise in class-rooms and at home and give more pleasure than perhaps anything else in the plant world. Still, one must follow certain directions for their potting and culture if success is to be sure.

In the first place, certain kinds of bulbs are easier to raise indoors than other kinds. These should always be chosen in work with young children. The narcissus group is the most satisfactory of all for this work. Choose such members as paper white narcissus, poeticus, Von Sion, jonquils and Chinese lilies. These last are usually the least satisfactory because their blooms blast when exposed to the slightest of draughts.

Hyacinths come next in choice. They fall into two general classes, the Dutch and Roman varieties. The Roman ones bloom earlier than the Dutch. If tulips are chosen, order the early blossoming ones; for on the slower growing varieties, plant lice often develop. Crocuses do well indoors, especially when planted in masses. These, then, are the easiest to raise of all the bulbs for indoor work, and the ones most likely to give success.

*A reprint of Brooklyn Botanic Garden LEAFLETS, Series I, No. 12.

Bulbs should be bought during September and October, for all potting ought to be over by the last of October. For this work with bulbs, have ready the bulbs, soil, sand, charcoal, broken crock and the pots.

The Bulbs.—In the first place, order these of any good seedsman. If hyacinths be chosen, remember that the named varieties are more likely to give good results, but they are more expensive than the unnamed ones. If one cannot afford the named varieties, order by color, such as the blues, whites, etc. Be sure to choose firm, solid bulbs. These have more strength to do their work; more food supply stored up. For, within the heart of the bulb the flower itself is already formed, ready to push itself up and out into the world, when conditions are right. So the strong bulbs are better fitted for their work than the weaker ones. Remember this, too: that Roman hyacinths bloom earlier than other hyacinths, requiring a shorter resting period. Those planted in October may be had for Christmas bloom.

Soil.—The soil for bulb planting should not be too heavy. Heavy soil clings firmly together when moistened, due to clay in it. Light soil falls apart. If the soil seems to be a heavy one, lighten it with sand, adding about one-third sand to the amount required. Sand not only lightens soil, but it helps by carrying surplus water off. In very heavy soils, water may collect about the base of the bulbs. This causes decay. Free the potting soil from lumps and stones; if it is necessary, sift it.

Pots.—Bulbs may be planted in pots, pans or flats. Pans are low crocks. Flats are low boxes of about four inches in height. The bottom of a flat ought to have holes in it or spaces for drainage. Many bulbs can be planted, just as closely together as possible, in a single flat. When the bulbs are almost ready to bloom they may be transplanted into separate pots. The number of pots to buy depends upon the number of bulbs. It is a matter of calculation. Bulbs need just enough space to grow in, without touching neighboring bulbs. Suppose the pot to be a five-inch one: allow two Dutch hyacinths to such a pot; three Roman ones; two

Von Sion daffodils; two paper white narcissus; three poeticus; four jonquils; five tulips, or four if they be large ones; six to eight crocuses, and eight to ten freezias.

Method of Potting.—After all the materials are gathered together, proceed with the potting after this fashion. The hole in the bottom of the pot is for drainage and to allow air to enter and

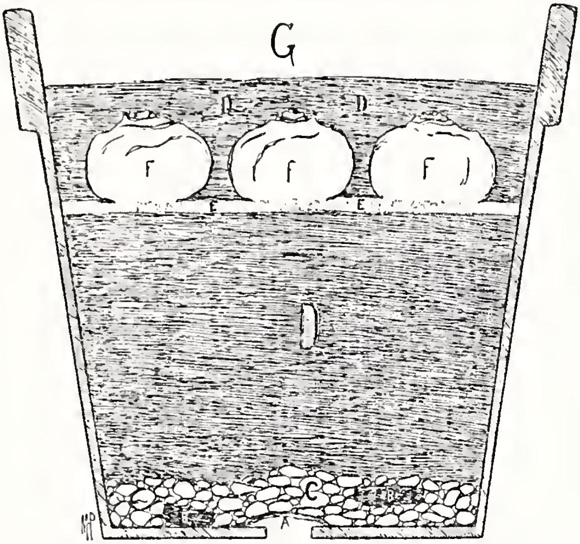

Fig. 5. Longitudinal section of flower pot, showing arrangement of potting materials and bulbs. A, curved piece of crockery over drainage hole; B, charcoal; C, drainage material; D, soil; E, layer of sand; F, hyacinth bulbs; G, space for watering.

get at the roots. This is important, for roots must have air. To be sure, some air is bound up in the soil, but the roots need more than this. Hence, the hole in the bottom of the pot is for this purpose, and should never be tightly clogged up. Place a curved bit of broken crock over the hole, with concave surface toward the hole. This covering prevents the soil from trickling through, or the water from passing out too fast; but it does not prevent the entrance of air. More air enters than if a straight piece of crock is placed directly across the hole. After this, put about an inch of drainage material in the pot, but less than this should go in shallow pans and flats. Materials to use for drainage purposes are crock, turf or sod, charcoal or even stone. These are spoken of as drainage material, because a loose area is formed through which water slowly trickles, and at the same time the soil is not clogged with too much water. Charcoal may serve a double purpose, for it is thought by some to sweeten the soil. It is perhaps well to use a piece of charcoal in each pot when other drainage material is not used. One, of course, can raise bulbs successfully without using charcoal at all. The soil goes next after this layer. Now comes another point to calculate, and that is the amount of soil necessary before putting in the bulbs. Find it out thus: hold the bulb to be used down into the pot so it is in the place it ought to be. Hyacinths should be potted so that their noses (the pointed end of the bulb is called the nose) are one-half inch below the surface of the soil; tulips, one-quarter inch below the surface; and the narcissus group above the soil. The upper surface of soil in a pot should be one inch below the edge of the pot. This space allowed is for watering, so that soil will not flood over the edge of the pot when water is put on. After this, put a little sand over the soil, a layer not more than an eight of an inch thick. This sand bed acts as a drainage area, allowing water to trickle down and away from the bulb. Now place the bulbs in their sand beds. Leave just space enough between the bulbs so that no two touch. Neither should they touch the sides of the pot. Cover with soil, pressing it down firmly about the bulbs. Now they are ready for the season of rest.

Resting Period.—All potted bulbs should be placed in a dark, cold place for six to ten weeks. Roman hyacinths may be brought in after a month's rest. The object of this resting period is to give time for the roots to develop slowly and surely before the plants are brought into the light. For as soon as this time comes, a bulb expends all its energy in forcing the flowers and leaves so the work of root making must be done before this time. If the roots are not properly developed, good results cannot be expected. The roots are properly developed when they begin to force their way out of the hole in the bottom of the pot. The pots may be stored for this resting period either indoors or outdoors. If they are to go indoors, select a cold, dark place, such as a cool cellar or basement. The bulbs must be watered once or twice a week. If they are to go outdoors, one of two methods may be employed. Either dig a trench in the ground for them; or prepare a box. If a trench is dug, it must be at least eighteen inches deep, and wide enough to take in the widest receptacles. Place two inches of coal ashes on the bottom of the trench. This layer assists drainage and offers an obstacle in the path of ascending worms. Now the pots of bulbs are placed on the ashes and soil put all about and above them. Fill in the rest of the trench with soil or coal ashes. Coal ashes form a looser layer than that made by soil, so it is easier to shovel off the ashes in cold weather. Never use wood ashes, because of the lye in them, which trickling down to the bulbs would kill then. Leave them thus until you wish to take them in. But allow six weeks for development. Nature does the watering. The second method, that of using a box, is an excellent one for use in schools. Get a box the size you wish; it should have a depth of at least two feet. Put an inch layer of sand, soil or ashes over the entire bottom of the box, placing the pots on this. Cover the pots in the box with sand and then fill the box full with coal ashes. In extreme weather put a covering over the box which is left outdoors, on the ground or a roof. Again nature does the watering. The box may be lined with a heavy wrapping paper, which insures greater warmth. Be sure to mark the pots with wax crayons. This is very essential in school work, so that children may receive their own pots.

Care of Bulbs—When the pots come out of the darkness, do not immediately bring then into direct sunshine. Let this be gradual, first leaving them in a darkened part of a room, and finally when the buds begin to open, see that they receive the direct sunlight.

Water freely, for it helps the blossom to unfold. Never let a pot stand where a draught strikes the plant or the blossoms will blast before unfolding. After the period of bloom is over, let the blossoms, leaves and all completely wither up. Then cut the stalks up to one inch from the bulb itself. Shake all soil from the roots and place the bulbs in the sunshine to dry out. Pack away in tin boxes. These bulbs may be planted outdoors the following fall, but are of little or no value for further work indoors. Chinese lilies can never be used again after one period of blossoming.

Water Culture.—Some bulbs will grow well in water, pebbles and water, or sand and water. Hyacinths do well in tall glasses which the florists and seedsmen sell for this purpose. Fill the glass with water, place the hyacinth in the top of the glass with the pointed end of the bulb up. Now place the glass away in a dark closet, but not necessarily a cold one, until the hyacinth's roots are way down to the bottom of the glass. Then it is time to bring it to the light. Chinese lilies and other members of the narcissus group may be planted in pebbles and water. The pebbles are placed in the bottom of the glass dish or earthen one. Upon this layer, place the bulbs, two to an eight ounce dish, and surround them with pebbles for the purpose of steadying the bulbs. Water should be poured in so that it just touches the base of each bulb. These dishes of bulbs ought to go into a dark closet until good root growth has developed. Paper white narcissus, Von Sions and poeticus may be buried in a bank of sand, but leave the noses of the bulbs sticking out of the sand. Treat these as you would those planted in pebbles and water, except that the entire sand mass must be always saturated with water.

Outdoor Planting.—An outdoor bulb bed is excellent for school grounds, being decorative and easy to plant. Tulips look well in round beds planted in one color masses. Border beds may be filled with daffodils or hyacinths. Crocuses, snowdrops, and little grape hyacinths are planted here and there in the grass.

The single flowered varieties of bulbs are more attractive than the double flowering kinds. In preparing an outdoor bed be sure that the soil is dug up and made fine for a depth of eight inches. Different bulbs are planted at different depths. Hyacinths should go six inches beneath the soil and six inches apart; narcissus and tulips, four inches down and four apart; crocuses, three inches deep and three apart; all small bulbs, like snowdrops, etc., should go only just beneath the surface of the soil. Cover the bulbs over with soil. When the weather becomes cold and just before frost, put about two inches of barnyard dressing (horse manure) over the beds. Later, as the weather grows colder, put a piece of sacking or heavy wrapping-paper over each bed. Hold these down with stones so that the wind does not blow the covers away. This last cover is not an absolute necessity. When the spring comes, take away whatever remains of the coverings and see the tips of the bulbs poking out of the ground. For outdoor planting, buy "bedding" varieties. Do not wait until late October or November to buy bulbs, for they lose value during the fall, shrinking and becoming less strong. The outdoor bulb bed may be left as it is after blossoming time. That is, the bulbs may be left in the ground, and the tops cut off. Of course, all the bulbs could be dug up, dried and planted out again the next fall. These bulb beds should have new bulbs put in about once in four years.

E. E. S.

NOTICES

The Garden is open free to the public daily, from 8 a. m. until dark; on Sundays and holidays at 10 a. m. The Laboratory Building, containing the library, herbarium, and offices, is open daily, from 9 a. m. until 5 p. m. The Conservatories are open April 1–October 1, 10 a. m.–4:30 p. m.; October 1–April 1, 10 a. m.–4 p. m.

The Garden may be reached by Flatbush Avenue trolley to Malbone Street; Franklin Avenue and Lorimer Street trolleys to Washington Avenue; St. John's Place trolley to Sterling Place; Ninth Avenue, Sixteenth Avenue, Union Street, Greenpoint and Smith Street trolleys to Prospect Park Plaza and Union Street, and Brighton Beach elevated to Consumers' Park Station. (The elevated trains stop only when the conductor is notified in advance.)

A docent will meet parties by appointment and conduct them through the Garden. This service is free to members of the Botanic Garden and to teachers with classes; to others there is a nominal charge of 25 cents an hour for parties of less than three, and 10 cents a person per hour for parties of three or more.

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Mr Kittredge

BROOKLYN BOTANIC GARDEN

LEAFLETS

THE BROOKLYN INSTITUTE OF ARTS AND SCIENCES

SERIES IV BROOKLYN, N. Y., SEPTEMBER 27, 1916. NO. 11

THE ORIGIN AND HISTORY OF OUR MORE COMMON CULTIVATED FRUITS

Ages before he secured his living by following the chase, primitive man doubtless eked out his existence on the roots, buds, seeds and wild fruits that grew in such profusion about him. But it was a long, long time before he learned to tame these wild productions and to pick out the best wild types—those which tasted best, furnished the largest amount of food and cost the least amount of labor. Many of our most common market fruits, such as the grapefruit, have been added to our larders only in comparatively recent times, and in fact, most of the best tropical fruits are still gathered from unselected seedlings—a fact which goes a long way toward accounting for the great difference of opinion concerning their quality and merits.

When one groups the cultivated fruits of the world according to their distinctive flavors, colors and forms, one finds there are about 100 distinct kinds, about one-half ot which reach our New York City markets. Many of these are worth trying out, but the quantities in which they come are generally so small and the price so high that only the curiosity of the fruit-epicure is tempted.

When fruits are grouped according to their ancestral leanings, a curiously striking fact comes to light, causing us to wonder how we could have been happy without the rose family. For the apple, pear, medlar, quince, shadberry, haw, loquat, peach, nectarine, plum, cherry, apricot, raspberry, blackberry and strawberry are all second-cousins of the garden rose. These rosaceous fruits are, with very few exceptions, natives of the northern hemisphere. Since we ourselves are supposed to have evolved in this region, it appears that we have been constantly associated with them for a long time, which may partly account for the esteem in which we hold this group of fruits. Our acquaintance began with most of them during the prehistoric centuries when our race lived in Asia and during their later countless migrations into different parts of that great continent and its European appendage. So it should occasion no surprise that most of these rosaceous fruits find their greatest development in number of varieties, both cultivated and wild, and in perfection of fruit, in this section of the world.

Wild apples, pears, apricots, cherries and plums form vast thickets on the mountain sides and pathless wilderness valleys of central and northern Asia. Wild plum thickets stretch for miles along the creeks and ravines of both Asia and North America, and in spring these thickets are one vast garden of flower and perfume.

The apples are generally small, crab-like and sour, but variation runs rife even among these wildlings, so that many a thicket tree produces fruit that is very palatable. One of the wild apple species has dark purple fruits, unfit to eat, but gorgeous in its rich coloring. Through hybridization, the time may come when we will have fine apples of this color. How far back into antiquity the association of man and the apple goes is in part answered by the occurrence of carbonized crab-like apples among the ruins of the Swiss lake dwellings of the Bronze age. The Romans are said to have first known apples about 449 B. C. Five hundred years later they had over a score of varieties. From Rome, the apple was brought to England, where in 1882, 1500 sorts were known. And in 1905 a bulletin of our own goverment described over 6,500 varieties, representing, however, only a fraction of the total number of kinds in the world. Though native to Asia and eastern Europe, the great apple growing regions of the world are the United States, western Europe, Tasmania, and southern Australia.

Two very different kinds of wild pears made possible the present great pear industry of the world, the wild pear (*P. communis*) of western Asia and eastern Europe and the hard, gritty sand pear of northern China. From the former came most of our eating pears such as the Bartlett, and from hybridizing the two species, came our cooking and long-keeping pears, such as the Kieffer and the Le Conte. The quince came to us through Rome and the island of Crete and the fruits in ancient times were called "apples of Cydon (Crete)".

Other apple-like fruits are the medlar, loquat, haw and juneberry, no one of which is as yet more than locally esteemed, although large orchards of big fruited haws are grown in China, and the loquat is beginning to be seen in our southern and western local markets. The loquat has a very distinctive sub-acid flavor, which will bring it into wider esteem as soon as certain shipping difficulties can be solved. The juneberry (shadberry) is still largely a fruit for pioneer districts, though it has great possibilities of improvement.

Next in importance to the apple-like fruits in the minds of the white race are the peaches, apricots, plums and cherries. The finest peaches we owe to China, though they went a very roundabout way to get to us. If one should see the little, hard, bitter wild peach of China, as some of our explorers have done, he would have been thankful that the Chinese became acquainted with it some twenty or more centuries before we did. Though our forefathers brought the peach over in our colonial days, the great peach industry of Georgia is based on direct importations of fine varieties from China. Some of the finest Chinese peaches such as the Fei reach a pound in weight. Very few varieties come to our markets as compared with the thousands which are known, but of these, those "clings" from Georgia rank as the choicest in flavor. The peach country of China abounds in legends concerning the peach tree, the beautiful peach-blossom color being symbolical of unchastity. Hence peach trees are seldom planted near the windows of the apartments of the women, for fear that the wives and daughters might develop the dreaded "peach-blossom heart." Many peach orchards with white flowers abound, thus eliminating the dreaded danger from the pink-flowered sort. In another ancient legend of the Rip Van Winkle type, youth is referred to as the peach-blossom time of life.

Like the wild peach, the wild apricot is not an inviting fruit except in its bright coloration. The wild apricots of Persia, China and Korea are small and very sour. The apricot, by the way, is regarded by certain church authorities as the "apple" of the bible, apples being unknown to the ancient Hebrews. In Syria at the present day apricots are dried in large quantities and pressed together in sheets 2 to 3 feet long resembling a blacksmith's apron. These sheets are known as "Moon of the Faithful." Imagine occidentals using such poetic names for such prosaic diet! In another dried form, they are more appropriately referred to as "mishmush". The great apricot orchards of the world now belong to California, from which over 300 cars of fresh fruit, and thousands of tons of canned and dried fruit are shipped annually. Fruits having both plum and apricot characters similar to those called "plumcots" by Burbank are known in various parts of Asia.

The forms in which wild or semi-wild plums occur are legion. Most authorities regard three species as largely responsible for our present day types. The common European plum comes from a thorny wild type common in western Asia and Europe with dark purple fruits, slightly larger than a good sized pea. To this form we are said to owe the prune varieties. Most of the fresh California plums not purple in color, are from a Chinese-Japanese wild species. Many of our own inland domestic plums are selections from our native wild plums, a type largely without meaty fruit, but described by one fruit expert as "bags of flavored sugar water." Various hybrids exist between all three types as well as with still other types. There are about 300 varieties of these native plums cultivated. Practically a seedless variety of prune exists. In California, where most of the plum orchards are devoted to the prune type, over 6,500,000 trees have been planted. Curious flat-shaped plums occur in China, as well as varieties with fruit that can be kept for several months. Plums, though a cosmopolitan fruit within reach of all, have, curiously enough, never been highly appreciated by either the white or yellow races.

While we often use such expressions as the "apple of my eye", "a peach", "peachy", no one would be complimented by being referred to as either a "plum" or a "prune".

Nearly all the 120 or more species of cherries are native to Asia, the great primitive fruit orchard of the civilized world. Of these, only two species are believed to have contributed our cultivated varieties, 600 or more of which are known to America and Europe. Of the two types, sweet and sour, the former is more largely grown commercially, forming the bulk of our California product. Black Tartarian and Napoleon are the two varieties largely marketed. Maraschino liqueur comes from the Marasca, a Dalmatian cherry. In China and Japan, many flowering forms are known, among which is one with yellow flowers (*Prunus serrulata*).

The wild raspberries and blackberries of the world (200-1500 species) form a common thicket vegetation all over the northern hemisphere with a few representatives in tropical and south temperate regions. The cultivated forms come from a few species and differ but slightly from these wild types—the main differences being in size of fruit. Many of the varieties are selected wildlings, while a few are the result of hybridization. The strawberry on the other hand is largely a hybrid product of four or more species, the large-fruited Chilean species predominating. The Chilean strawberry was introduced about two hundred years ago; but, even two centuries before its coming, the cry of "Strawberry ripe" was heard in the streets of London. These old-time varieties were derived from the native European species. White, yellow and pink-fruited varieties occur. The white and yellow varieties are solid-fleshed and good keepers, and very popular in Chile.

After the rosaceous fruits, tropical and sub-tropical fruits such as the banana, pineapple, orange, lemon, grapefruits and melon are the most common and important fruits of our city markets.

Fifty years ago, the banana was hardly known to Americans; today, it is the people's fruit (witness the recent agitation against a tax on its importation). So common and so cheap has it become that it is hard not to think of it as a distinctly American product along with corn, turkey and tobacco. The fact is, however, that the banana is native to India and the East Indies, where to-day it exists in hundreds of varieties of which the white race knows very little. The wild varieties have large, hard seeds. In our own tropics between 35 and 45 varieties of plantains and bananas are grown, only three of which commonly reach our city markets. Of these, the variety Jamaica, or Gros Ventre, forms the bulk of the importations, over 8,000,000 bunches being annually exported from Jamaica alone. One of the old world varieties has fruit a foot long, with an apple-like flavor. It has been estimated that the same area required to raise 33 pounds of wheat or 99 pounds of potatoes will produce 4400 pounds of bananas, making the banana a very cheap article of food from the standpoint of cost.

The pineapple belongs to the same family as the long gray "moss" that hangs from the trees in our southern forests. Many varieties are known, but as usual, only a few are grown commercially. Several near relatives of the pineapple produce fruit much esteemed locally.

The citrus fruits are all old world Asiatic species. The sweet orange came to us by way of Persia from Southeastern Asia ages ago and is now distributed wherever it will grow, over 70 varieties being cultivated in United States. The principal California variety is the Washington Navel, introduced into this country in 1870 from Bahia, Brazil, where it was discovered about 1824. The orange lives a long time, trees in Spain being said to be over 600 years old. Individual trees have been known to produce 6000 fruits in a single year. Ranking next in importance to the orange is the grape-fruit, that peerless breakfast and dessert fruit of the city man. The grapefruit, native to the islands lying to the south of Asia, was brought to the West Indies early in the eighteenth century, but the present commercial culture started in Florida only about 25 years ago. Like the orange, it exists in numberless forms, the large pyriform shaped ones being known as "shaddocks". Some of these measure two feet in girth. Some are pink-fleshed. Seedless forms of the grapefruit, excellent in quality, now come to our markets. Along about Christmas time, baskets of small, oval, perfumed oranges are common in the fruit stores. These are kumquats, the spiced orange of Japan, eaten skin and all, or used for preserves. In the orient many curious kinds of citrus fruits are known, one of the most peculiar being the fingered citron. Another kind is called the soap orange, and Safford says it is a common sight in our island colony of Guam to see women and girls, waist deep in water, vigorously rubbing clothes with soap orange pulp and a corn cob. Many hybrids between the various citrus fruits are known, some of which are natural, others being artificially made. Professor Swingle of our Department of Agriculture is especially interested in this hybridization work, as is also Professor Webber of the University of California. As a result of their work, new types of citrus fruit are being produced such as limequats, citranges and tangelos, the latter being a hybrid between the tangerine orange and the grapefruit.

The melon family is of ancient cultivation, a painting of a cut melon being found in the ruins of Herculaneum. The muskmelon was known during the Hebrew sojourn in Egypt and is supposed to have been brought from there to Rome, thence to France in 1495 and later to England. The finest muskmelons were once said to have come from Bokhara, a country lying near the native home of this fruit. The wild type is extremely variable; most of the fruits are said to vary from the size of a plum to that of a small apple. This is hard to believe from the size of fruits we now have, some of which weigh over 14 pounds. Three types of muskmelons are found in our fruit stores, green and yellow fleshed melons and the cassaba, the cape or winter muskmelon. The latter in general is inferior in quality to the other types, but is esteemed because it comes when the others are largely out of season. In western Asia, one variety occurs with fruit which is buried in soil while growing, otherwise it never develops a desirable flavor.

The watermelon comes from Africa, the wild form occurring in numerous varieties in the deserts of South Africa. The fruit of this wild type varies in size from that of a ball to that of a man's head and is either sweet or bitter in taste. During the winter months in these desert regions it is often the sole source of water for the cattle caravans. Yellow, red and white-fleshed varieties are known, as well as varieties with yellow rinds. The latter facts have given rise to the erroneous notion that they easily mix with pumpkins. Varieties with melons weighing 30 pounds are not uncommon.

Perhaps next to the apple, no fruit means more to the white race, from the standpoint of sentiment, than the grape. In the early years of our own country, numerous unsuccessful efforts were made to transplant this century-old companion to our soil. But it was not until we settled California that it found a congenial home. Although more than twenty-five varieties are grown commercially there, three constitute the bulk of the vineyards: Flame Tokay for fresh fruit, Zinfandel for wine, and Alexandria for raisins. In 1913, the California vineyards were estimated to cover 385,000 acres, an area about half the size of Rhode Island. In the same year these vineyards produced 6,363 carloads of table grapes, in addition to tons of raisins and millions of gallons of wine. Of raisins, California produces over half the world's crop. The common white California grapes are Malagas, while the reddish-black late grape is the Emperor. The so-called dried or Corinth currant is a small grape which is successfully grown only in in Greece, though numerous attempts have been made to make it commercially successful in California. During the winter, enormous bunches of fine black, white and red greenhouse-grown grapes are to be found in our markets, some of which weigh as much as 10 to 20 pounds. More than two thousand varieties of the old world grape are known, all of which trace their ancestry back to the wild grapes of Western Asia, a region in which to-day the wild, unpruned, uncultivated vines clamber over the tall trees in tropical luxuriance, producing their richly-colored fruit in abundance. Remains of grapes have been found in the ancient lake dwellings of northern Italy of the age of Bronze, showing that these ancient peoples knew the grape as well as the apple. So much for the old world grape—the grape of poetry, romance and sentiment.

The new world grape, of which over 84,000 acres are grown within twelve hours ride of our city, has no ancient traditions. Its value was only realized when its old world relative refused to grow here. So in the last hundred years, such varieties as the Concord, Delaware, and Niagara have become commercially important. These varieties possibly are hybrids with the old world form, though there is much difference of opinion on this point among the authorities. From Concord, Mass., the Concord came, a result of the interest and work of Ephraim Bull. This variety produces most of our grape juice, and a large share of our fresh fruit.

What our cereals, meat and fruit are to us, the date is to the Arab. According to an ancient legend, when God created Adam, a few grains of dust slipped between his fingers, and from these sprang the date-palm trees. Thus among the Arabs this tree is referred to as "My aunt". Its cultivation is more ancient than the Arabs themselves. The clay tablets of the Assyrians describe its culture and uses in minute detail. According to De Candolle and others it was probably native to the ravines of the desert regions of Arabia and northern Africa. Apparently it was first cultivated by the Assyrians in the region of the Euphrates river, later in ancient Egypt (2000-3000 B. C.), and still later it became the friend and the basis of the national industry of the Arabs. A form of the date-palm with sourish fruit is sometimes doubtfully referred to as the wild ancestor. The date was brought to America from Spain, where it had been introduced by the Moors. Recently in this country, date culture has been tried from a commercial standpoint and an experimental orchard set out by our government at Tempe, Arizona. Fresh fruit of the finest kinds are now sometimes procurable in small quantities in our markets. Dates exist in hundreds of kinds, with a great range in quality. The finest varieties, such as the Deglet Noor and Bentamouda, are very difficult to obtain for propagating purposes, as their owners refuse to sell offshoots of them, but give them away as tokens of great esteem. Three general types of dates are recognized, only one of which (the soft date with high sugar content) commonly comes to this country. Of the other two types, one contains a much smaller percent of sugar, hence will not stand transportation as well, and is used as we eat grapes. The other type is a dry, hard sort, not sticky, but often of excellent quality, which may be stored for several years without deteriorating. Date culture was once practiced in China, but now the jujube and the persimmon, both of which are natives, largely takes its place.

The jujube is sometimes referred to as the date-plum. It is a sweetish fruit, existing in many varieties, some of which are as large as a hen's-egg. I have never seen it in our markets, though doubtless it is locally procurable in California. One of our explorers predicts its commercial planting on a large scale in the near future. In China, jujubes are dried. Some varieties are used to bake in bread as we do raisins.

A delightful Chinese fruit that is common in fruit-stores during the winter is the "kaki" or persimmon. In color it resembles a tomato, but the common variety here is top-shaped, though in China there is great variation in shape, some being ribbed and furrowed, others smooth and flattened. Seedless varieties of these persimmons are known. The wild form from the mountain sides has small, sour, puckery fruits largely consisting of seeds. A relative from Mexico has greenish fruits with excellent flesh of about the color and consistency of axle grease.

The fig in all probability was native to southern Arabia, ages ago. Since then forms apparently wild have covered the whole of western Asia, southern Europe and northern Africa. Once it reached the shores of the Mediterranean, its distribution was rapid though the channels of this distribution lay through two different peoples, the ancient sea wanderers, the Phoenicians and the Greeks. The Phoenicians had distributed it over the major part of the great Mediterranean basin in all probability before it reached the Greeks. The first authentic reference to the fig in Greece was about 700 B. C. Later the Athenians were nicknamed "fig-eaters". The she-wolf nursed the infants Romulus and Remus under a fig tree in ancient Italy, so runs the legend. And from our school readers we learned how Cato held up a bunch of fresh figs from Carthage (Tunis) as evidence of how near the hated country was to Rome. The fig is supposed to have reached China about a century before Christ was born. The Spanish and French first brought it to America. Later, our government interested itself in importing fine varieties. For about a thousand years, the figs of Algarve, Portugal, dominated the markets of western Europe. Then the figs of Smyrna, of which, in good years, 30,000 tons are exported, replaced them. The Californian product exceeds 4,000 tons. Over 400 varieties of figs have been described. Many close relatives of the fig are known, among which is the common rubber plant.

Gooseberries, cranberries, currants, groundcherries and blueberries are comparatively modern fruits, their commercial cultivation in most cases not dating back more than four hundred years. In fact the cranberry industry is not more than one hundred years old and largely American, while cultivation of blueberries is still in an experimental stage though Mr. Coville of our Department of Agriculture has demonstrated that it can be done. Most of the cultivated varieties of these fruits differ but little from the wild forms. The same is also true of many tropical fruits.

One hesitates to start a discussion of tropical fruits so near the end of the allotted space. First, because they are legion, second because there is such a difference of opinion concerning their merits, and third because of the great differences among the fruits of the same name. In New York, when one buys a mango, he never specifies the kind he wishes as he does with apples. Consequently his first experience may be an unfortunate one. Mine was. It tasted like pumpkin with threads drawn through it, flavored with turpentine. Subsequent experiences however largely convinced me of the veracity of those writers who claim it to be one of the finest of fruits. The best varieties have absolutely no stringiness nor hint of turpentine flavor. There is great variation in size, some varieties having fruits no larger than an English walnut, while one very rare variety is said to be as large as a cocoanut.

But even better than the finest mango, according to many connoisseurs of tropical fruits, are the mangosteen, durian and the litchi and its relatives. The mangosteen, for sheer beauty and temptability cannot be beaten. Were it not for profound authority, one would be forced to believe this fruit the "apple" that resulted in Adam's fall. Though externally a beautiful fruit, about the size of a small orange, with a smooth, brilliant reddish purple skin, its real beauty lies beneath its skin. You cut through this leathery covering, and a fruit composed of orange-like segments, snow to ivory white in color comes in view. The cut skin surface is a delicate pink, studded with yellow droplets of juice. Where the segments come together, the flesh has a pale green translucency. Covering the segments is a delicate network of of fibers. The flesh is so delicate that it melts in your mouth "like *fine* ice cream". In the words of one admirer, "the flavor is quite indescribably delicious, and resembles nothing you know of and yet reminds you, with a long after taste, of all sorts of creams and ices." Another describes the taste as suggestive of grapes and peaches. This fruit is native to the East Indies, and unfortunately never reaches our markets, though it is said to retain its flavor twenty-five days after picking.

Many nice people never eat onions and certain kinds of cheese because of their offensive odor. The five- to seven-pound fruit of the durian tree combines these two odors with that of turpentine and in addition is covered with sharp half-inch spines. Notwithstanding its armor and offensive odor, it is regarded as one of the tropics' most prized possessions. "Eating durians is a sensation worth a voyage to the East" writes one devotee. "Resembling blanc-mange, delicious as the finest cream," writes another.

The litchi never reaches our markets in a fresh state, though in the orient and East Indies, this is the form in which it is commonly eaten. In the dried form in which they reach us, they taste like a very fine prune, and are covered with a warty easily broken shell. Many varieties and several related species with similar fruit are known. When fresh, the fruit somewhat reminds one of bright crimson strawberries. The pulp is juicy, translucent white in color, and a pleasant bitter sweet in taste.

The alligator pear or avocado is common in our markets and worth a trial by those who like salads. Cactus figs have been common fruits this season. Although native to America, the fruit is grown largely in Sicily and North Africa. Pomegranates need no introduction to those who came recently from Europe. The sprightly acid flavor is very refreshing and the bright red color of the pulp adds to their tempting qualities.

Sapodillas are chocolate brown fruits of fair flavor about the size of an apple. The spicy, slightly acid pulp of the red and yellow guavas are much better than guava jelly. Granadillas or the fruits of the passion vine are rather insipid, the pulp resembling gelatine dessert with a sour-sweet flavor. St. John's bread is a brown pod of a pleasant sweet flavor, which is common and cheap in the East side markets. St. John is supposed to have lived for a time on this fruit (locust) and wild honey. Tamarinds are another pod fruit of a sweetish sour taste. They come in little baskets after the holidays. Custard apples, soursops, and sweetsops can be obtained in some of the fancy fruit stores during the winter. As with most tropical fruits, there is great difference of opinion concerning their desirable qualities, largely, as I have already said, because most of these fruits are gathered from seedlings. Eventually when these fruits are grown in large commercial orchards from budded or grafted stock of a few selected varieties, there probably will not be such diverse opinions.

ORLAND E. WHITE.

A table of various fruits, giving their names, probable length of time of cultivation, their country of origin, and short comments, is appended. The letters indicate in a general way the antiquity of their cultivation. The starred names indicate those fruits the writer has found in the city markets. Many of the more uncommon of these fruit trees are to be seen in the greenhouses of the city's two botanic gardens.

A—cultivated for more than 4000 years.
B—cultivated for more than 2000 years.
C—cultivated for less than 2000 years in the old world.
D—cultivated very anciently in America.
E —cultivated before the discovery of America, but with no indications of very ancient culture.
F—cultivated since the discovery of America. Often only very recently.

Name	*Date*	*Origin*	*Remarks*
*Apple	A	E. Europe, W. Asia	Very different type common to China.
Actinidia	?	N. E. Asia, China	Tastes something like a gooseberry, with a fig flavor.
*Alligator Pear (Avocado)	E	West Indies, W. South America to Chile	Excellent salad fruit.
Anchovy Pear		West Indies	Unripe fruit pickled.
Akee	F	W. Tropical Africa	Much esteemed cooked fruit in Jamaica.
Achocon	F (?)	Peru	Relative of the violet. Much esteemed locally.
*Apricot	A	Central Asia, China	Wild species variable.
*Blackberry	F	United States	Wild species very variable.
*Blueberry	F	E. and N. North America	Four species. Often confused with huckleberry.
Buffalo-berry	F	N. W. United States	Very acid, bright red or yellow fruit. Local.
Breadfruit	?	East Indies	Baked and eaten as a vegetable.
*Banana	A	Southern Asia	Exists in hundreds of varieties.
Cashew	?	Tropical America	Fruit excellent as preserves.
Chupa-chupa	F	Colombia	Apricot-mango flavored.
Citron	B	India, S. Asia	Very variable.
*Cranberry	F	E. and N. North America	Cultivated for about 100 years.
*Currant, Red	C	Northern Hemisphere	White and yellow varieties are forms.
*Currant, Black	C	N. Europe and Asia	Rarely cultivated in America.
Cambuca	?	Brazil	Sub-acid garden fruit. Local.

Name	*Date*	*Origin*	*Remarks*
*Cactus-fig	E	Mexico, West Indies	Common New York City fruit.
*Cherry, Sour	B	Asia Minor, S.E.Europe (?)	Locally common.
*Cherry, Sweet	B	S. Europe, E. Asia	N.Y.City markets from California.
*Custard Apple	?	Tropical America	
Chirimoya	E	Ecuador, Peru	Repeatedly dug up from prehistoric graves in Peru.
Duku	?	Malay Peninsula	Fine Malayan fruit, somewhat turpentine in flavor.
Durian	F	Malaysia, East Indies	Odor of old cheese, rotten onions flavored with turpentine. Delicious except for odor.
Dewberry	F	South and Central North America	Form of blackberry.
*Date	A	Arabia, North Africa	Hundreds of varieties.
*Fig	A	Southern Arabia	Wild form common.
Genip	?	N. South America	Children' fruit.
Genipap	?	American Tropics	Used for a refreshing drink locally.
Grumixama	?	Brazil	Much like bigarreau cherry.
*Grape, Old World	A	Western temperate Asia	California and Old World grape.
*Grape, New World	F	North America	Many probably hybrids.
*Grapefruit	B	Malayan and Pacific Is. east of Java	Largely cultivated in U. S.
Groundcherry	F	Barbadoes, W. South America, Asia	Three or more species.
"Goumi" berry	?	Japan, China	Delicious acid fruit.
*Gooseberry	C	N. Europe, N. Africa, W. Asia, United States	Old and New World species distinct. New World varieties in some cases hybrids.
*Guava	E	Tropical America	Fruits of several species used.
Haw (2 species)	?	China, S. United States	Local fruit.
Icaco	F (?)	Tropical America	Common fruit in San Salvador.
Jaboticaba	F	Brazil	Common fruit tree around Rio Janeiro.
Jujube, Common	B	China	Very excellent dried fruit in China.
Juneberry	F	United States, Canada	Locally esteemed.
*Kumquat	?	Cochin-China or China	Resembles very small oranges.
Lulo	F	Colombia	Tomato-like fruit.
*Litchi and relatives	C	S. China, Malay Archipelago	Finest Chinese fruit. Numerous forms.
*Loquat	?	Central-eastern China	Much esteemed in China and Japan.
*Lime	B	India	Largely used for limade and citric acid.
*Lemon	B	India	
Marmalade Plum	E	Mexico, N. E. South America	Resembles in taste a ripe luscious pear
Mammee Apple	?	West Indies to Brazil	"St. Domingo apricot."
Marang	?	Sulu Archipelago	Similar to but much better than breadfruit.
Matasano		Central America	"Delicious."
*Mango	A (?)	India	"Should be eaten in a bath-tub."
Mangosteen	?	Sunda Islands, Malay Peninsula	King of tropical fruits.
*Muskmelon	C	India, Beluchistan, W. Africa	Hundreds of varieties.
Monstera	F	Mexico	Pineapple-banana flavor.
Mulberry, Black	B (?)	Armenia, N. Persia	Most valued for fruit.
Mulberry, White	A (?)	India, Mongolia	Most valued for feeding silk worms.
Medlar	C	Central Europe to W. Asia	Local apple-like fruit.
*Nectarine	?	Cultivated form of peach	Smooth skinned.

Name	*Date*	*Origin*	*Remarks*
Natal Plum	F	South Africa	Local fruit for preserves.
*Orange, King	?	Cochin-China	Recently common in N.Y. City markets.
*Orange, Tangerine	?	Cochin-China, China	
*Orange, Sweet	C	India	Numerous hybrids with other species.
*Olive	A	Syria, Southern Anatolia and neighboring islands	Does not fruit in Florida.
Papaw	F	Southern United States	Local fruit related to the custard apple.
Papaw, True	E	Tropical America	Excellent breakfast fruit.
*Passiflora	F (?)	Tropical America	Used locally for ices, fruit salads, jams, etc.
Piñuela	?	Mexico, Central America and N. South America	Sold cooked in Mexico. Common market fruit of Caracas.
*Pineapple	E	American tropics	Red Spanish and Sugar Loaf, common market varieties.
*Peach	A	China	Hundreds of varieties.
*Pear	A	Temperate Europe and Asia, N. China	Two species, and hybrids between them.
*Pomegranate	A	Caucasus, Persia, Afghanistan, Beluchistan	A seedless variety is known.
*Plum	A	S. Europe, W. Asia, N. America	Much hybridized group.
*Plantain			Form of banana.
*Persimmon	?	Northern China	Common in N. Y. C. markets:
*Quince	A	Persia to Turkestan	"Apple of Cydon" (Crete).
*Raspberries, Red	C	N. Europe, Asia, North America	Varieties and hybrids of two species.
*Raspberries, Black	F	Middle N. America	Locally much esteemed American fruit.
Rose-apple	B	Malaysia, S. Asia	Rosewater taste and perfume.
Rose-apple relatives		Tropics of Old and New Worlds	Many promising local fruits.
Sapote, Black	F	Mexico	Relative of persimmon.
*St. John's Bread	A (?)	Syria, S. Anatolia, Barca ?	Common dried pod fruit in N. Y. City.
Soursop	?	West Indies	Locally esteemed.
*Sweetsop	?	West Indies	Locally esteemed.
Shaddock	B	East Indies	Large pyriform relative of grapefruit.
*Strawberry	F	Temperate N. America, Pacific coast of N. and S. America, Europe	At least three species involved. Mostly hybrids.
Sandcherry	F	N.W. United States	Local fruit.
Strychnos apple	F	Bush veldt of S. Africa	Tastes like clove-flavored pears.
*Sapodilla	E	West Indies, Central America, N. South America	"Chicle" or chewing gum made from its sap.
Star apple	E	W. Indies, Central America	Delicious. "Damson plum."
Tahiti apple	?	Society, Friendly, Fiji Islands	Common tropical fruit.
Tahiti apple relatives	?	South America	Common West Indian fruit.
*Tamarind	B (?)	Either India or N. Africa	Occasional N.Y. City fruit.
"Tomato," Tree	?	Peruvian Andes	Apricot-flavored tomato.
*Watermelon	A	Tropical and S. Africa	Often a desert plant.

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TEACHERS' NUMBER

BROOKLYN BOTANIC GARDEN

LEAFLETS

THE BROOKLYN INSTITUTE OF ARTS AND SCIENCES

SERIES IV BROOKLYN, N. Y., OCTOBER 11, 1916. NO. 12

TALKS FOR ELEMENTARY SCHOOL CLASSES

The Brooklyn Botanic Garden here announces its fourth series of talks and lessons for schools, to be given October 16th to November 17th. These talks, as those preceding, have been planned to correlate with the New York City course of study in Nature Study and Geography.

It might be of interest to compare the course of study in these subjects and the work planned by the Brooklyn Botanic Garden, since our work is arranged to supplement that done in the class-room. The lessons given at the Garden are of such a nature that they may be given in any class-room with the simplest kind of apparatus. After the work required in the syllabus for each grade has been taken up, the talks and lessons offered at the Botanic Garden will prove advantageous.

Under Nature Study in the syllabus for 4B these subjects are suggested for study:

> "Seedless plants: ferns, mosses, mushrooms, lichens, seaweeds. Parts; color; spores, treated in an elementary way.
>
> "Cultivation of plants. Review of the needs of plants. Propagating plants by seeds, by slips, by runners; growth of roots of slip in water. Life histories of maple, oak, strawberry, apple, peach, plum; seed, seedling, root, stem, leaves, flowers, fruit; methods of propagating new plants.
>
> "Forms of stems: erect, prostrate, climbing by tendrils, twining by stem or petiole; why plants seek erect position; underground stems (potato) and bulbs (onion); uses of stored nourishment to plants."

We offer for Grade 4B the following talks and lessons:

1. *Common ferns for your homes and class-rooms.*
2. *How to raise plants in different ways.*

3. *The families of oaks and maples; how to distinguish these trees when you see them.*
4. *What plants need for growth. (Experiments).*
5. *Bulbs: how to plant and care for them.*

FROM THE SYLLABUS IN NATURE STUDY FOR 5B:

"Trees. Uses to tree of bark, of wood, and of pith; annual rings and medullary rays (study cross and long sections of pieces of woods); uses of heart wood and of sap wood to plants and to man; movements of sap (maple); blossoming and fruit-formation of fruit and shade trees; use of wood in building and in furniture (collections); use of trees in relation to rainfall. Emphasis should be given to the protection of trees in city streets.

"Plant products useful to man: Vegetables classified as roots, stems, leaves, bulbs, or fruits. Fruits classified as fleshy, stone, and dry. Medicines and spices: bark, leaves, sap, extracts. Clothing: cotton, linen. Woods: those used for building or furniture; characteristics which fit them for this use.

"Classification of Plants. Evergreen and deciduous trees; shade and fruit trees; trees, shrubs, and herbs; plants with one seed leaf (monocotyledons), and with two seed leaves (dicotyledons); parallel veined and netted veined (pinnate and palmate)."

We give the following talks:

6. *How trees live and grow.*
7. *Plants useful to man. (Cotton, rubber, tea, coffee). (Lantern slides).*
8. *How to know the common evergreen trees.*
9. *A few common deciduous trees. (Outdoor study).*
10. *Common bulbs to raise at home and school.*

SYLLABUS FOR 5B GEOGRAPHY:

"(1). Location of the States in each group; location with reference to the United States as a whole and to the other countries of North America, if bordering; surface and climate; important rivers. (2). Resources. Soil, forests, mineral and oil deposits, fisheries. (3). Industries and products. Agriculture, grazing, lumbering, fishing, mining, manufacturing."

11. *How soil is made. (Experiments).*
12. *Lumbering in the United States.*

SYLLABUS FOR GRADE 6A GEOGRAPHY:

"South America. Location, surface, and climate; leading countries and chief cities; industries, products, and commerce; the people."

13. *Coffee culture in South America. (Slides and living plants).*
14. *The rubber industry in South America.*

SYLLABUS FOR GRADE 7A GEOGRAPHY:

> "Natural resources. Location of areas of natural resources, including (1) agricultural products, such as corn, wheat, cotton, sugar, tobacco, forest trees; (2) mineral wealth, such as salt, iron, coal, oil, gas, copper, silver, and gold; (3) the fisheries in both inland and coast waters; (4) the water power obtained from the rivers."

15. *Agricultural products of the United States. (Lantern slides).*
16. *What plants mean to the world's commerce. (Lantern slides).*
17. *The life story of a tree. (Demonstration and slides).*
18. *Forestry. (Lantern slides).*

The work in certain grades is of such a nature that a botanic garden has little to offer in direct correlation. Therfore, certain special talks and demonstrations are offered to any and all grades above and including the fourth grade. Certain subjects are of such common and growing value that a study of them benefits the child, no matter what grade he is in. There is also a certain civic value resulting from the visit of a class to one of its city institutions. Such talks are the following:

19. *The sort of plants to raise in your class-room.*
20. *How to make Brooklyn a more beautiful city.*
21. *How Nature prepares for the winter. (Plant material used as illustrative material).*
22. *Ten common trees in our city.*

There may be other talks on botanical subjects and nature study which teachers desire, and which do not appear on the above list. Such talks, as far as possible, will be given on application by the teacher. All applications should be in writing on cards furnished by the Garden for this purpose. These cards read as follows:

School.................................... Grade........................ No. of Pupils..................
Address..
Date...

THE ASSISTANT CURATOR OF PUBLIC INSTRUCTION

BROOKLYN BOTANIC GARDEN

I wish to bring my class, as indicated above, to the Botanic Garden on date.................................. at hour.................. for purpose checked below:

1. *Talk No.*.................. *for Elementary School Classes.*
2. *A special talk on*..
3. *Special work in the plant houses.*
4. *Visit the conservatories under guidance.*
5. *Visit the out-of-doors collections under guidance.*
6. *Visit the Japanese Garden.*

School telephone........................ ....Teacher

(Additional copies of this card may be had on application)

Teachers are specially requested not to bring classes without having notified the Garden.

Ellen Eddy Shaw.

NOTICES

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BROOKLYN BOTANIC GARDEN

LEAFLETS

THE BROOKLYN INSTITUTE OF ARTS AND SCIENCES

SERIES IV BROOKLYN, N. Y., OCTOBER 18, 1916. No. 13

SOME EARLY BOTANISTS

The new building of the Brooklyn Botanic Garden, now nearly completed, will contain on its walls about seventy names of distinguished botanists.* The great majority of these belong in the period from Linnaeus to the present time. In this LEAFLET are mentioned some of the writers about plants who lived earlier than Linnaeus.

Aristotle, pupil of Socrates and teacher of Alexander the Great, has been called the father of natural science. His writings are extensive and have in large part come down to us; those on plants, however, have been lost. Aristotle recognized the pioneer character of his work. "Mine is the first step," he writes, "and therefore a small one. You, my readers, must judge me with indulgence." However, his writings were authority for nearly two thousand years.

Theophrastus of Eresus, called by Linnaeus the father of botany, was born about the year 370 B. C. on the island of Mitylene, where Aristotle taught Alexander. He became the pupil, friend and successor of Aristotle. The grove near Athens where Aristotle had taught became, under Theophrastus, the first botanic garden. Theophrastus wrote on many subjects; his "Characters" has been widely translated and imitated. His "History of Plants" describes about five hundred kinds of plants. In this work four groups are taken up: trees, shrubs, half-shrubs, and herbaceous plants; under each there are cultivated and wild plants. Very few wild plants are described; "there are many others," says Theophrastus, "but they have no names." It is said that Theophrastus lived nearly a hundred years, and, according to his wish, was buried in his garden.

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*These names were chosen by vote of American botanists as described in the *BROOKLYN BOTANIC GARDEN RECORD*, IV, No. 4, October, 1915.

Dioscorides was a Greek physician of the first century A. D. Little is known of his life, but it is evident from his writings that he had traveled considerably. His work on medical plants was considered a final authority for sixteen centuries; numerous editions and commentaries were published.

Pliny the Elder was a Roman admiral, a friend of the Emperor Trajan, and wrote books on many subjects. His economy of time, writes his nephew, was almost beyond belief. He was killed by the eruption of Vesuvius, A. D. 79. His interesting "Natural History" was intended to be a general compendium of knowledge of nature; it contains thirty-seven books, sixteen of which describe plants and medicines from plants. A great many manuscripts and printed editions are in existence. The great prestige of Pliny's work was largely due to its being the only work of its kind in Latin, the language of learning of the middle ages.

Very little was added to the knowledge of plants between the time of Theophrastus and the sixteenth century. During the middle ages, it has been said, the **Arabs** kept aflame the lamp of knowledge. Plant names, such as Oryza (rice), Alfalfa, Alkanna, and others, testify to their studies. According to the so-called "doctrine of signatures," plants indicated in some way their use—by heart-shaped or liver-shaped leaves, etc. Writings about plants during the middle ages were connected with their use in medicine, and often described magic and rites to be used when gathering or preparing the herbs. That the plants of Central Europe might be different from those of Southern Europe described by the ancients was not considered.

The invention of printing and the discovery of America profoundly influenced all scientific study, including that of botany. The German Fathers of Botany, Brunfels, Tragus, and Fuchs, were the first to make pictures and descriptions direct from nature. **Brunfels** was in monasteries till probably past fifty. His "Herbarum Vivae Icones", published in 1530, contains 135 illustrations, often with short phrases from Theophrastus or Dioscorides. A few plants unknown to the ancients are given, but these are not named.

Hieronymus Bock, more generally known by his Latin name **Tragus**, also called Jerome the Herbalist, collected plants for many years. He writes that "when information about my labors and travels had been conveyed to the most learned Otto Brunfels of pious memory, he himself came journeying all the way from Strassburg to Hornbach, to see my gardens and collections." His "Neu Kreuterbuch" contained at first no pictures, but German descriptions of plants. He describes herbs, shrubs, and trees, "keeping together such plants as nature seems to have linked together by similarity of form." His characters are chiefly vegetative ones.

Leonard Fuchs, a Bavarian, and also friend of Brunfels, was for thirty years a professor of medicine at Tübingen. Our common plant, *Fuchsia* is named after him. His "Stirpium Historia" contains five hundred large plates, arranged alphabetically by Greek names.

The "Botanologican" by Euricius Cordus, is an interesting account of imaginary conversations about plants between Cordus and his friends. It clearly explains that the plants of the ancients do not grow in Central Europe. His son, **Valerius Cordus,** lectured on botany in Wittenberg, and died in Rome at the early age of twenty-nine. His works were published after his death. He urged botanists to cease copying the descriptions of the ancients and to describe anew from nature. According to Tournefort, he was "the first of all men to excel in plant description."

In Italy the first of modern botanic gardens were started in Padua in 1545, and in Pisa shortly afterward. **Luca Ghini,** the first to make a scientific herbarium, was the teacher of **Andrea Caesalpini,** who emphasized the importance of the fruit in classification, as against vegetative characters. His work, "De Plantis Libris", was published in 1583. Woody plants and herbs are a fundamental division, says Caesalpini, because the most important function of plants is to take up food through the root and stem. The second function is reproduction, therefore the fruit is the second thing to be considered in classification.

An important work, *Pinax Theatri Botanici* (1620), by **Gaspard Bauhin**, of Basle, described more than six thousand species of plants, many more than any previous work.

Joachim Jung, of Hamburg (1587-1657), was the first to state that woody plants and herbs should not form a fundamental division. For example, a locust tree which has pea-shaped blossoms should evidently be grouped with the pea; the woody stem is a minor character. More than a century passed before this idea was generally accepted.

The perfecting of the compound microscope, especially by **Robert Hooke,** and the anatomical studies of **Malpighi** and **Grew,** prepared the way for greatly improved botanical systems.

The, "Historia Plantarum", by **John Ray,** published near the end of the seventeenth century, marks a great step forward. While keeping the divisions of woody plants and herbs, Ray makes, under these, the important sub-divisions of monocotyledons and dicotyledons, an improvement ignored by Tournefort and Linnaeus. Ray also first clearly segregates the flowerless plants as a group, although he makes them a sub-division of the herbs.

About the same time (1691) **Camerarius** of Tübingen first conducted experiments proving that pollen is needed to produce perfect seeds. His important writings passed almost unnoticed for a century.

The botany of **Tournefort** (1656-1708) was in many respects less satisfactory than that of Ray. However, by the very clear exposition, particularly of genera, his work proved very suitable for reference, and became the standard authority until the time of Linnaeus.

In later LEAFLETS other names which appear on the laboratory building will be taken up.

ALFRED GUNDERSEN

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BROOKLYN BOTANIC GARDEN

LEAFLETS

THE BROOKLYN INSTITUTE OF ARTS AND SCIENCES

SERIES IV BROOKLYN, N. Y., OCTOBER 25, 1916. NO. 14

THE ANCIENT HISTORY OF PLANTS

The earth has been estimated to be anywhere from 25,000,000 to 400,000,000 years old. Man, in all probability, appeared upon it between two thousand and three thousand centuries ago. The historic record, as deciphered from the remains of ancient civilizations, possibly extends back seven to eight thousand years. This record, contrasted with the age of the earth (conservatively estimated at 120,000,000 years), is as a quarter-second is to the passing of an hour, or, as some one has more graphically put it, "as the flashing of a meteor through the sea of night." The oldest known plant remains are probably less than half the earth's age, but antedate man by millions of years. The earliest vegetation which the rocks have shown us, in any quantity, is far from simple in type, most of the forms being trees, shrubs, or woody ferns. Immense layers of rock strata still older than these exist, however, from which only the merest vestiges of plants have been taken. Hence, grounds exist for supposing these earliest plants to be already many stage-journeys along the road of evolutionary progress. Already they have an eon-old ancestral tree.

During those first ages when the earth's crust was forming, land was scarce, and the seas were new and filled with fresh water. Hence, the first plants were sea-born, distant relatives of our present-day pond-scums and slimes. As the centuries passed, innumerable rivers filled the seas with decomposed mineral matter. They lost their freshness. Only the more adaptable of the earlier vegetation remained, while the less adapted types existed only in the fresh-water areas of the slowly appearing continents. From the former, perhaps, came our present-day seaweeds; from the latter, our fresh-water green scums and slimes. Between the seaweeds, so far as the rock-written pages testify, and the rest of the plant kingdom, a great gulf exists—an almost entire absence of connecting links. A very few petrified moss and liverwort fragments have been found, but these furnish practically no clue as to their ancestral relations, either to the pond-scums and seaweeds on the one hand, or to the ferns, conifers and flowering plants on the other.

Mosses and seaweeds being rather delicate plants with no woody parts, the comparative scarcity of their petrified remains is rather to be expected. First, because only a relatively small portion of these most ancient plant graveyards have been explored and only vegetation most favorably placed has been preserved. Second, since the earliest types of vegetation arose, the land and sea areas which they inhabited have undergone great alterations. The earth's crust has been repeatedly crumpled into mountain ranges and grooved into valleys, only to be rumpled and creased anew. Mountain chains have risen, only to sink and rise again.

Seas have receded in many places and encroached on the land in others. Lakes have been cut out and rivers formed to carry off their surplus waters. Great oceans of ice have swept down from the north, levelling hills, cutting valleys, and moving thousands of tons of rock and soil. It is hardly necessary to state what would become of fragile plant remains amid such turmoil.

Hence, the rock-written story of the evolution of plants is largely concerned with those having woody stems—in other words, the ferns, club-mosses, horsetails, conifers and flowering plants. As to the primitive ancestors of these already complex types, we can only speculate. As to whether the mosses and liverworts are an offshoot from the main ancestral trunk which terminated in our flowering plants, a distinct section of it, or a backstep from some fern type, can be more definitely discussed only when the rocks have given up more of their facts—when the plant graves have given up more of their dead.

If the rock strata of the earth's crust had undergone no volcanic or other serious disturbance during the time it was laid down, one might visualize a section through it as a slice cut from a huge cake composed of many layers, each layer differing somewhat in composition and texture from the one beneath it. But earthquakes, volcanic activity, and other alterating forces have distorted, upheaved, and otherwise played havoc with the regularity of these layers until even a geologist has his troubles in correctly identifying their different outcroppings. These layers being laid down in sequence, the bottom one is naturally the most ancient, as well as the hardest to investigate. In order to make them easier to study, many layers are grouped together, and the time in which they were laid down is called an era. These eras are again subdivided into periods, etc. The three main divisions, or eras, are generally known as the Paleozoic, Mesozoic and Cenozoic, the latter taking in the present time.

Certain kinds of plants were most plentiful and formed the predominant flora of each of these divisions. Hence they are often known respectively as the age of pond-scums, seaweeds, primitive seed-plants, ferns, club-mosses, and horsetails; the age of conifers, cycads, and ginkgos; the age of flowering plants* (our own age). Beneath the Paleozoic rocks lie immense thicknesses of other rocks, the pre-Cambrian, almost if not entirely devoid of fossil remains, hence as yet contributing nothing to the story of plant life.

In fact, the first beginnings of the imperfectly connected history of the world's flora, past and present, is found high up in the rocks of the Paleozoic era, an era perhaps as long or longer than the two succeeding ones combined. Here, over midway through this immense deposit, lie imbedded the remains of countless forests—forests of a far different aspect and relationship than the hardwood and conifer forests of today. Here lie the known remains of at least two or three great branches of the ancestral tree of our plant world—the ferns; the club-mosses, horsetails and their relatives, and the groups of fern-like seed-plants which ages after gave us the cycads, modern conifers, and flowering plants. But preceding this period which we know as the carboniferous, or age of coal, is a stretch of time and a deposit of rock, of which as yet little is known, but of which that little makes us believe it to be probably the most interesting and most momentous in all plant history. For along its low coasts, with broad marshes, over which the sea tides came and went for long distances, arose perhaps the first land plants. Here, through the centuries, they learned to crawl out of the sea and by degrees adapt themselves to a life on *terra firma*. Here perhaps began the ferns, horsetails, club-mosses, seed-bearing cycad-like ferns, and the earliest relatives of the conifers. Speculation runs rife in this mysterious region, this nebula of the land-plant world. Some authorities believe our great land plant flora developed from types similar to our fresh-water scums and slimes through the liverworts; others equally authoritative suggest they arose as sparsely small-leaved tide-water plants from the numerous plant forms of the ancient seas. Be that as it may, one fact stands out clearly, *i. e.*, the presence of the two (or three?) great woody plant groups at the beginning of the coal period, and the absence of annual rings in their stems, denotes a land of perpetual summer, unmarred by seasonal changes. These two or three great groups are separated by very distinctive characters, such as the size of their leaves, the position of their fruiting bodies, and the nature of their internal anatomy.

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*One should not think of these divisions of geological time as more sharply separated than historical periods.

As one traces these groups through the luxuriant but damp and gloomy forests of the coal period, one finds many strange trees. Giant club-mosses (Lepidodendrids, Sigillarians) with trunks 50 to 100 feet high, clothed with long, spiny leaves or diamond-shaped leaf scars, compete with both low-growing and tree-like types of ferns, each exceedingly abundant. Tree-like horsetails (*Calamites*) filled the swamps and their somewhat distant relatives, the *Sphenophyllales*, with curious foliage and slender, twining stems, were common. The cycad-like ferns, with "near-seeds", disputed the low grounds with the calamites, while the ancestors of the conifers (*Cordaitales*) with long slender trunks surmounted by densely branched crowns with large leaves, occupied the higher ground. These magnificent though strange and gloomy forests of the coal age were not confined to America, but characterized the flora of the whole world, east, west, north and south, indicating a climate much the same from Arctic to Antarctic. These queer forests from man's standpoint were very uninviting, as they lacked those elements which today make them cheery—birds, flowers, and butterflies—although some rather objectionable inhabitants were present, such as cockroaches, frogs, scorpions, and centipedes. Huge "snake-feeders," or dragon flies with wings over two feet in spread, flitted hither and thither over the calamite marshes, while pop-eyed, queer-shaped members of the frog and salamander group made these already dark and gloomy swamps more hideous and uncanny with their croakings.

The majority of our coal fields are the carbonized remains of these immense forest and swamp areas, conditions at that time being especially favorable for their preservation as coal. All the soft and cannel coals when properly treated, cut into thin sections and subjected to microscopic examination, show wood structure, or, in the case of cannel coal, myriads of crushed pollen grains and spores with other swamp debris.

At the close of the more or less tranquil coal period, the earth again became restless. Vast changes occurred. Mountain ranges arose (among them our own eastern mountains). Enormous areas in the southern hemisphere, and to a lesser extent in the northern, were overrun by seas of ice. Europe and western North America, in part, dried up into deserts.

Plant life, very naturally, was much affected by these various changes. The giant club-moss forests were doomed, and disappeared, only remnants existing in out-of-the-way places until the end of the Paleozoic era. The swamp-loving calamites were more fortunate, their extinction not taking place until the coming of the next era, where they gave place to the true horsetails, a much more lowly type, but perhaps better fitted to cope with the changing conditions of the long stretch of time between then and now. Ferns were more abundant than ever, running riot in variety of form and adaptability. The same was true of their near relatives, the curious cycad-like ferns which bore seed-like structures. Moreover, representatives of true cycads (sago palms) appeared. The forests of *Cordaites* gave place to still higher types of conifers, some of which had foliage similar to our present-day yews. Others were probably ancestors of the temple conifer, (*Ginkgo*) the curious maiden-hair tree, which escaped extinction from our present flora, only because it found favor in the eyes of an oriental priesthood.

The closing of the Paleozoic era marked the doom of the club-mosses, selaginellas, horsetails and their relatives as a dominating element of the earth's flora. In the coal period they had reached their millenium, both in grandeur and variety of form and in number of individuals. Henceforth to the present time, their history has been one of increasing insignificance. Today they are represented by a few very modest, inconspicuous types such as the ground pines of our northern forests, the selaginellas or little club-mosses so common as ground carpets in tropical forests at certain elevations, and the scouring rushes (horsetails), inhabitants especially of low swampy regions and of railroad embankments. This latter group in some forms still reaches a fair height, 15-20 feet, and in a few regions, they are still locally a large element of the vegetation,—relics of the past, much as are the redwoods of the Pacific coast, a group of plants once common over the whole world from Greenland to Australia.

Contrasted with the tranquil Paleozoic, the next era, the Mesozoic, is an age of marvellous activity and change, with a climate for the most part mild and seasonless. Climatic zones slowly put in their appearance as the age progressed toward its close. These zonal differences in temperature were probably slight at first, and more noticeable on the sea, the Arctic waters being cooler. Mountain making took place on a grand scale and volcanic activity, especially near the close of the era, must have presented scenes rivaling those once claimed for Gehenna, the old-time biblical hades. The result of all this turmoil and change lies before us today as the Cascades, Sierra Nevadas and the Rockies.

Animal life also seemed to be outdoing itself, especially in an effort toward grotesqueness in form and gigantic proportions. Reptiles of innumerable shapes and sizes walked and crawled over the land, swam the seas and filled the air with their whirring wings, some of which had a spread of twenty feet. Seas and rivers swarmed with crocodiles and huge turtles. Winged dragons with bird-like heads and teeth-filled jaws were no superstition in those days, nor were the mountains of flesh and bone, 50-70 feet long, which took the form of plant- and animal-eating dinosaurs,—animals, the largest the world has ever known. Birds were uncommon almost to the end of the era, while mammals (animals which suckle their young, such as are most of our present-day land animals) were small, few and insignificant.

The plants of such a world were no less marvellous, especially toward the latter half of the era, when representatives of our modern flowering plants appeared. In the first part of the era, ferns became less abundant and resembled many of our tropical forms of today. The club-mosses were much simpler and largely stragglers, while true horsetails, in canebrake-like thickets occupied the margins of the swamps, inland lakes and seas, in place of the calamites of the age just passed. Cycads were so

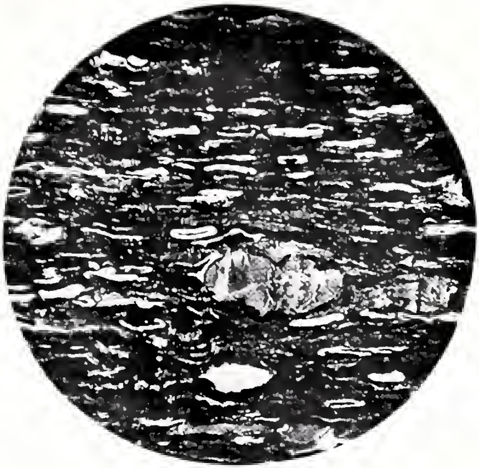

Fig. 1. Microphotograph of a thin section of cannel coal, showing remains of crushed spores. (After E. C. Jeffrey.)

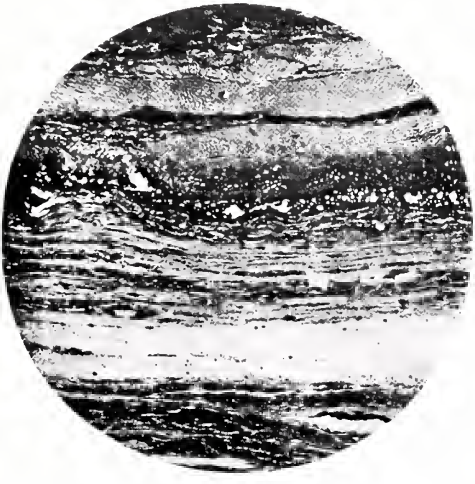

Fig. 2. Highly magnified microphotograph of a thin section of Illinois coal of the carboniferous age. Note the remains of wood structure. (After E. C. Jeffrey.)

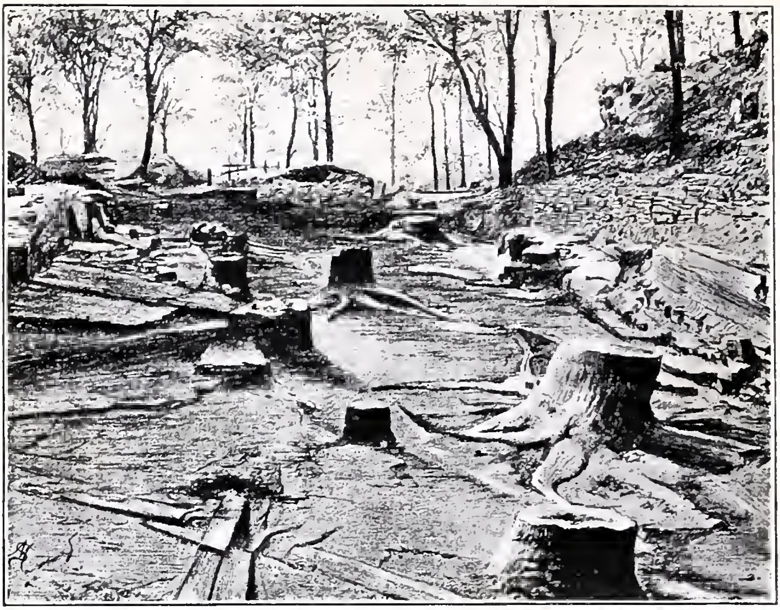

Fig. 3. Fossil tree stumps in a carboniferous forest, Victoria Park Glasgow, Scotland. Probably remains of giant club-mosses. (After Seward.)

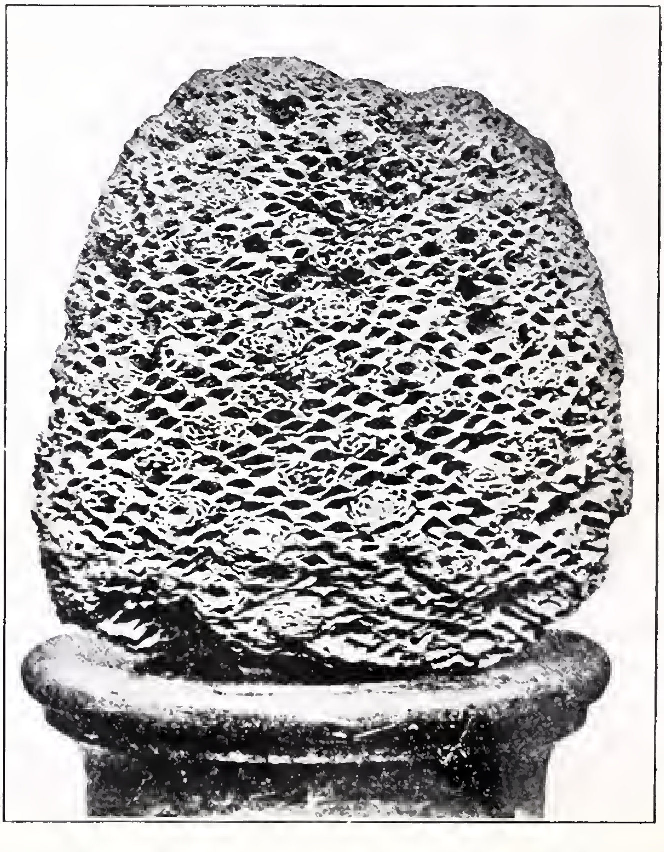

Fig. 4. A fossil cycad trunk from Maryland. (After Wieland.)

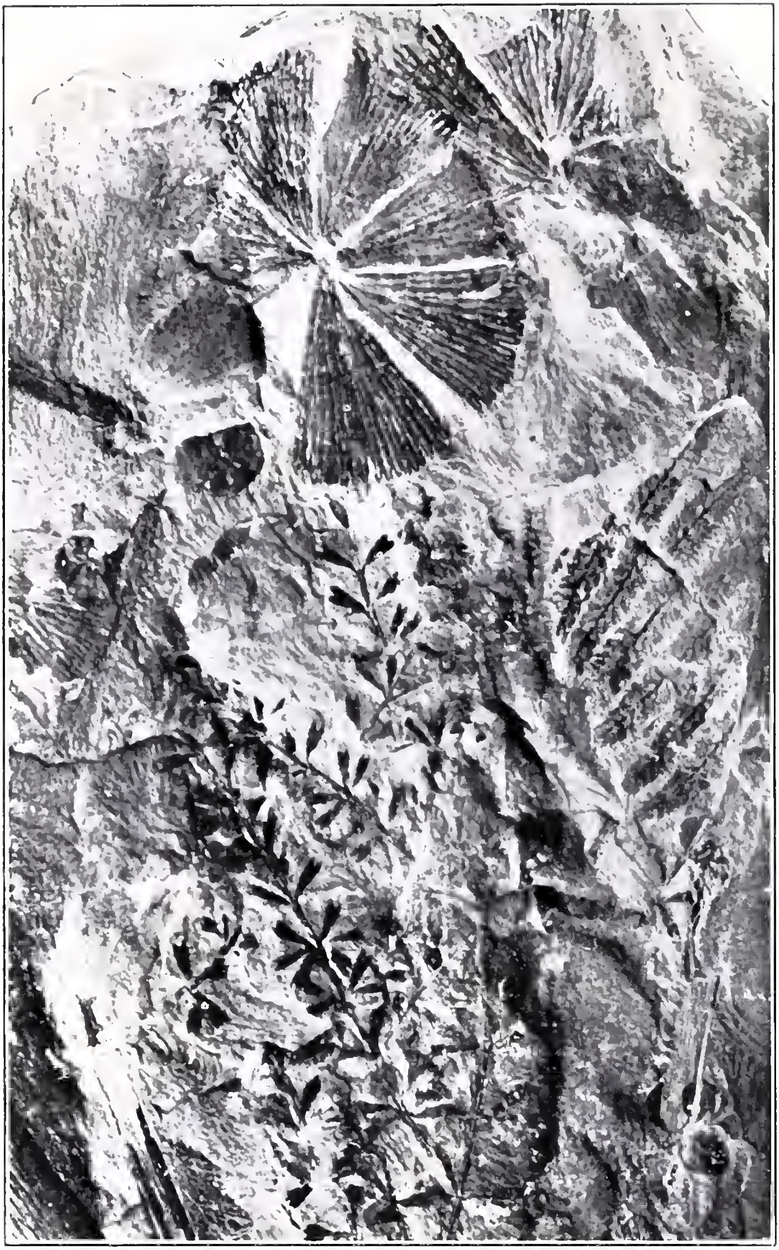

Fig. 5. SPENOPHYLLALES from the coal measures of Missouri Two species, magnified about 2 times, are shown. (After U. S. Geological Survey.)

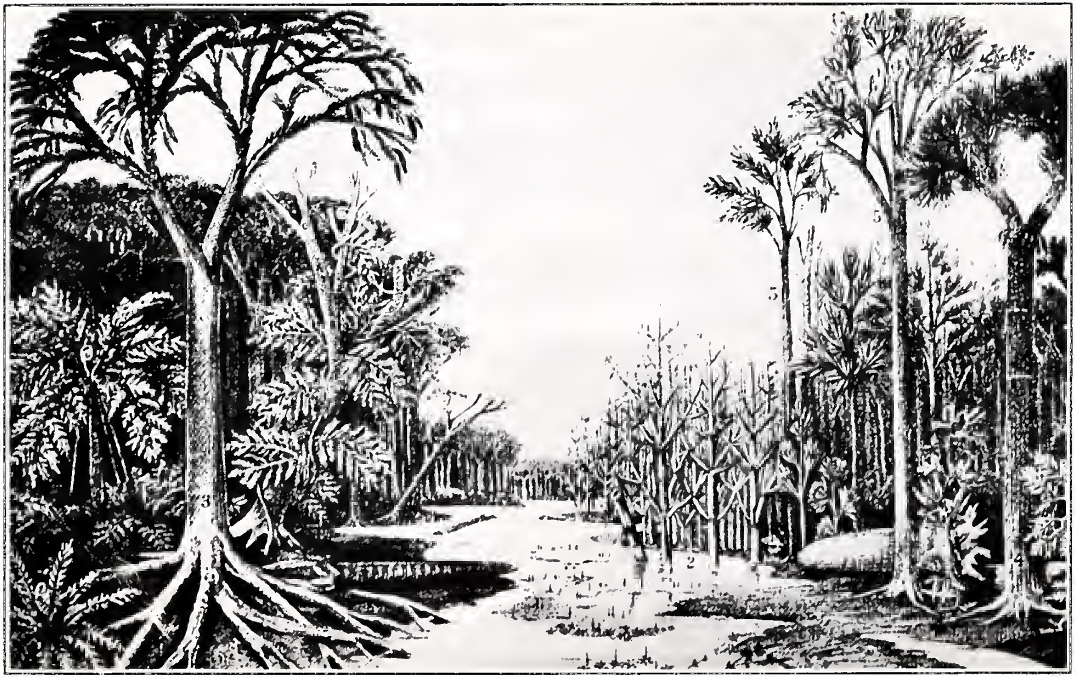

Fig. 6. A probable carboniferous landscape: 1, a tree fern; 2, *Calamites*; 3, 4, *Lepidodendron* and *Sigillaria*, giant club-mosses; 5, *Cordaites*, a primitive conifer. (After Potonié.)

common in the lowlands near the swamps as to give the era its name "Age of Cycads". Today their fossil remains are widely distributed over the earth—in Greenland, the United States, Mexico, northern Asia and other regions, now far too cold for them, for their living representatives are mainly found in either the tropics or sub-tropics. The hills were covered with dense forests of conifers, the relatives of our present day pines, cypresses and araucarias (Norfolk Island pines). These early Mesozoic landscapes, though luxuriant, were still gloomy, without the cheery song of bird or the bright colors of flowers. The fern forests of New Zealand are said to give the best modern picture of the plant life of this period. The beautiful agatized forest of Arizona (Chalcedony Park), one hundred square miles or so in area, is one vast cemetery of their remains. Where once, ages ago, probably existed a beautiful and flourishing vegetation now is naught but desolate desert, where even the adaptive flowering plant has a hard time to preserve its existence.

As the Mesozoic era progressed toward its noon, cycads became ever more diversified in form and more abundant. Today, the paleobotanist Scott estimates the ratio of cycads to other vascular plants as about one per thousand, while in the Mesozoic era, their ratio was about one in three. Their distribution was world wide, cycad fossils being especially common in New Jersey, England, Maryland, northern Mexico and the Black Hills area of South Dakota and Wyoming. In England, the miners called them "crow's nests", while in the West our ranchmen refer to them as "petrified cactus". The latter region is probably the richest cycad cemetery in the world, over one thousand trunks belonging to twenty-nine or more species having been unearthed or picked up there. Most of these belong to a peculiar group known as Bennettitales, forms with "flowers" somewhat resembling magnolia blossoms. This remarkable similarity has led several investigators to think they might be the primitive ancestors of our flowering plants. Other investigators, however, equally prominent and authoritative, believe plants related to our pines and spruces to have been the more likely progenitors.

In the main, the middle Mesozoic flora was a continuation from that of the earlier part of the era, the chief difference being in the greater abundance of characteristic Mesozoic plants, such as ginkgos, cycads and forms of horsetails, conifers and ferns. Northern Europe was covered with tree ferns, such as now grow in much warmer regions. In the extreme north (Spitzbergen), tree trunks have been found showing annual rings, indicating the begining of seasons—the coming of winter and summer. Over the rest of the earth, however, the evidence points toward the existence still of a warm, moist, sub-tropical climate.

And thus we come to the latter half of the Mesozoic, that part of the era in which occured an event of more profound importance to the world, as seen through man's eyes, than either the publication of "Darwin's Origin of Species", the French Revolution, or the discovery of America. For, in this part of the era, we first find flowering plants imbedded in the rocks. From whence they came and what were their ancestors is still largely mystery. Curiously their most ancient remains have been found only in a few areas in the northern hemisphere and from this, one may infer that here they originated, later migrating as successful settlers to every nook and corner of the world, excepting the oceans. These early flowering plants appear to have been largely trees and shrubs, among which were sassafras, poplar, fig trees, tulip trees and others. Of course, herbaceous forms may have existed on the higher lands, but being comparatively fragile, were not preserved.

Later, when the newcomers had secured their bearings, many new types appeared, such as oaks, maples, walnuts, ivies, hollies, elms, beeches, chestnuts and several kinds of monocotyledons (plants with one seed leaf) such as sedges, palms and grasses. Before the end of the era, flowering plants were covering the land at a prodigious rate, new forms arising by the hundred, compelling the cycads, ferns and even the conifers to fall into the background. Monocotyledons are said to have been found with the most ancient remains of flowering plants. The oldest fossil of one of their principal families (the palms) was discovered in France and resembles, in both fruit and leaf, our modern cocoanut palms. Greenland at this time, instead of being a cold, ice-bound, forestless wilderness with a meager alpine vegetation, had at least a temperate climate, with a flora of elms, oaks, maples and magnolias.

The Cenozoic era, from a plant standpoint, started right, but failed to keep its early promise. At its outset, the climate was mild and equable, with a luxuriant vegetation flourishing far within the Arctic circle. By slow degrees with many see-sawings, the atmosphere grew colder, the latter half of the era being marked by a reign of ice. Though glaciers only covered part of the northern and southern hemispheres, it is probable that the temperature of the whole earth was considerably lowered. Mountain-making during the first part resulted in the Alps, Caucasus, Himalayas and in further elevating the Rockies. Almost all the continents were united by land connections at different times, as well as disunited. It was an age of travelling, probably on the grandest scale the world has ever known. Land animals and plants, because of climatic and geographical changes, were apparently continually on the move—here, there and everywhere. The whole living world turned gypsy. The elephant family came to America and camels and horses, originally native to our continent, crossed over to Asia. The reptilian monsters died, and as with the Paleozoic clubmosses, left only their comparatively small and insignificant relatives, snakes, crocodiles, etc. to keep alive their traditions. In their place came the mammals, including man. Fish, bird, beast and plant, in general, differed but little from those of today, though their distribution over the globe has undergone remarkable changes.

In the forepart of the era, subtropical temperatures prevailed in Europe and the United States. Mingled with the ferns, horsetails, pines, sequoias (redwoods), and yews, relics of the more ancient vegetation, were the willows, elms, palms, bananas, myrtles, beeches, magnolias, and walnuts of the modern period. Fossil ginkgo leaves have been collected by the hundred in western Montana, where now are forests of spruce and cottonwood. Palms grew in northern Germany, and Alaska had a temperate climate flora. Cycads were rare, and had practically assumed their present position. Lemurs and primitive monkeys swarmed in the North American forests. Poisonous snakes were still unknown. Little horses no bigger than a cat, with toes instead of hoofs, roamed the grassy, park-like glades, while the dusky, forest aisles and subtropic nights first heard the swish and squeak of flying bats.

As the era sped forward and the climate slowly cooled, the monkeys willed their forest homes to the squirrels and disappeared from this region. Plant life greatly changed.

Grasses multiplied and prairies arose. Magnolias, beeches, and sycamores still lived as far north as southern Montana, while the bread-fruit (similar to our tropical form) grew in Oregon. Palms flourished in Colorado. Conifers were extremely abundant and of many kinds. Sequoias (redwood, "big trees" of California) of many varieties during this era were distributed all over the world, both south and north, instead of being confined to their present small Pacific coast area. Europe, perhaps, in its flora, was more like the India of today—a mixture of temperate and subtropical plants. Little is known of the North American flora just preceding the glacial period, but in Europe tropical and subtropical forms gradually disappeared, while temperate forms, such as tulip trees, poplars, and oaks, took their place. Plant life just before the reign of ice approximated very closely that of today, though it was differently distributed. Tulip trees, sequoias, and magnolias, once plentiful, have long been absent from European flora, while the ranges of many of our North American plants have been much altered.

While the earlier part of this era was marked by great volcanic activity all over the northern hemisphere, the latter part is remarkable for its reign of ice. Several great ice sheets swept over parts of the northern and southern hemispheres, and reindeer lived as far south as France and Arkansas. Arctic plants came south during the glacial period and retreated north again during the periods of mild climate, or up the mountain peaks, which answered the same purpose, *e. g.*, the Alps and the White Mountains. Climatic changes resulted in the extinction of much of the northern flora; hence, today the southern hemisphere, where climatic changes perhaps were not so destructive, is a vast museum of relics of a flora that was once world wide, while in the northern hemisphere, in general, the plants are much more modern. Somewhere during this era, possibly in Malaysia or southern Asia, man appeared, and, at the time of the ice age, he had discovered Europe.

Since his coming, changes in geography, climate and plant distribution have been and still are in progress, as any serious student of these subjects will tell you. New forms of plants are still arising, as any plant-breeder or modern-trained student of plant evolution will affirm. These are no longer subjects for argument; from the realm of theory they have been transferred to that of fact. Today the oldest living things are the giant sequoias or redwoods of California, some of which are over 3,000 years old. Today the plant world is largely dominated by the flowering plants, both in number of species and individuals. From this standpoint the following list of plant species belonging to each of the large groups may be interesting, though the number of species sheds but little light upon the actual numerical predominance of individuals of a species in a given flora. These figures are approximations:

Flowering plants	125,000
Conifers	450
Ferns	3,500
*Club-mosses and allies	500
Mosses and liverworts	12,000
Fungi and bacteria	64,000
Lichens	5,500
Algae (seaweeds, pond slimes, etc.)	14,000
	224,950

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*From the standpoint of the fossil record and those who study it, there is no justification, save that of custom, for considering the club-mosses as fern allies. If these students have correctly interpreted the rock-written records, the ancestors of our preseut-day ferns and lycopods are much further apart than ferns and flowering plants, at least as regards the time element.

After reading this Leaflet, if one is interested enough to read a more extended popular account, either D. H. Scott's "The Evolution of Plants" or Seward's "Links with the Past in the Plant World" will be found very entertaining. "Hypothetical ancestral trees" have a tendency to promote dogmatism in the casual reader, but, if one is interested, several of the latest, embodying the views of America's most eminent authorities, may be found in chapters 36-38, C. S. Gager's "Fundamentals of Botany." "Outlines of Geological History," by Willis and Salisbury, will interest those more technically inclined. There are other ways, of course, than those of studying the fossil record by which one may investigate the evolution of plants, but the latter probably gives the most accurate data.

Orland E. White.

NOTICES

The Garden is open free to the public daily, from 8 a. m. until dark; on Sundays and holidays at 10 a. m. The Laboratory Building, containing the library, herbarium, and offices, is open daily, from 9 a. m. until 5 p. m. The Conservatories are open April 1–October 1, 10 a. m.–4:30 p. m.; October 1–April 1, 10 a. m.–4 p. m.

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A docent will meet parties by appointment and conduct them through the Garden. This service is free to members of the Botanic Garden and to teachers with classes; to others there is a nominal charge of 25 cents an hour for parties of less than three, and 10 cents a person per hour for parties of three or more.

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